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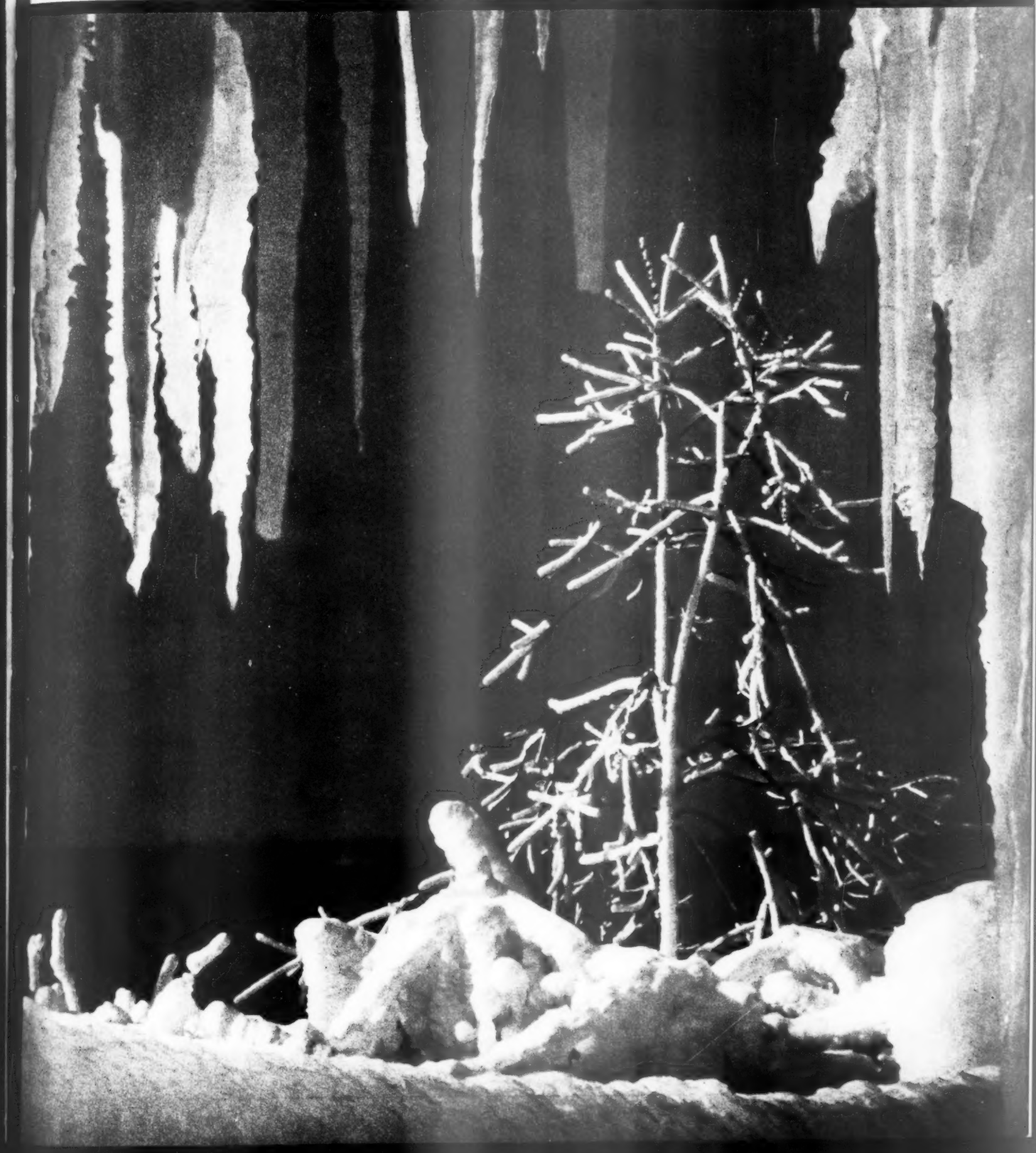

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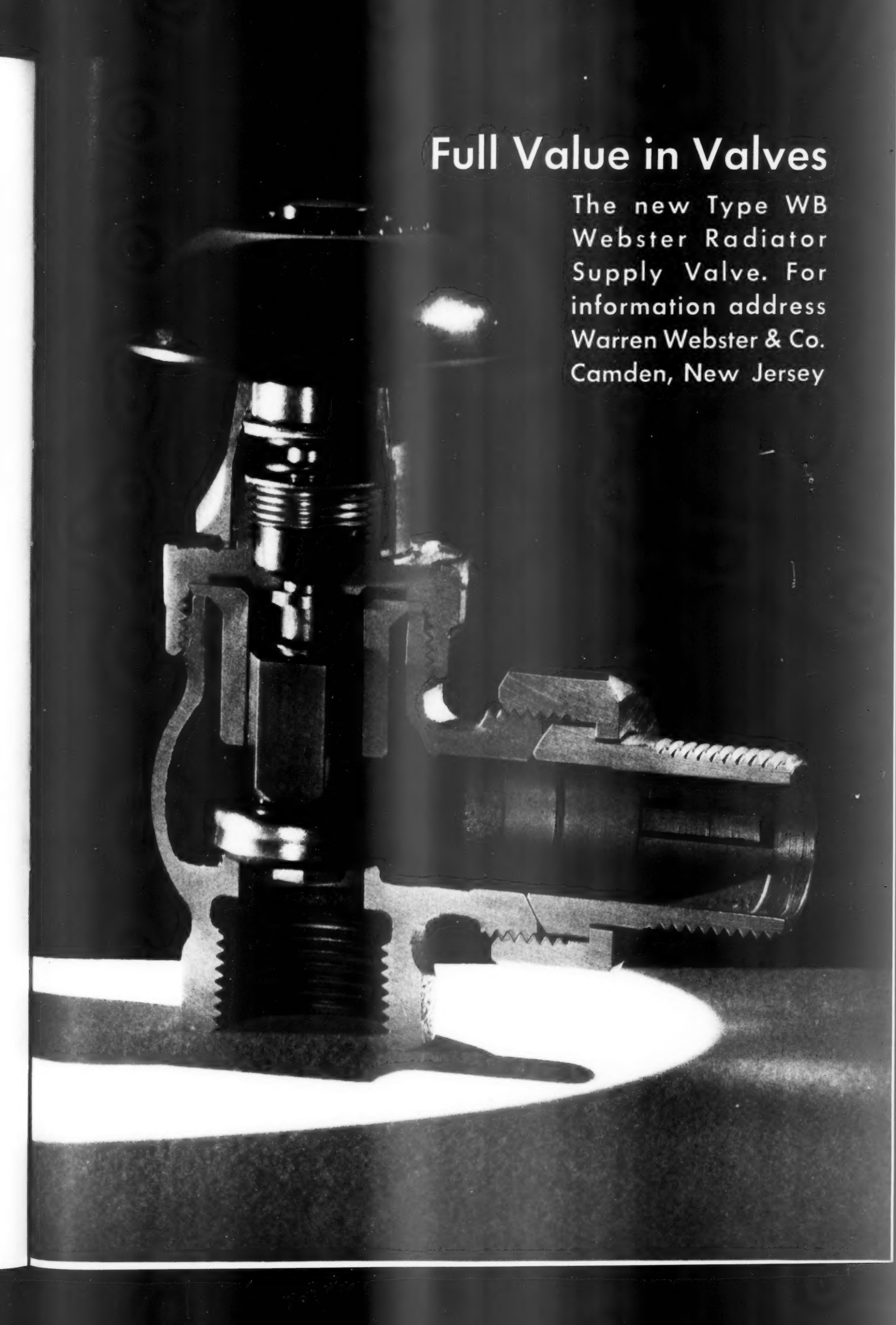
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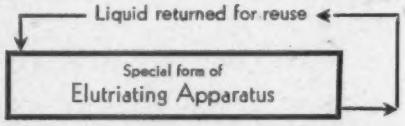

powders. The liquid under test had to be circulated around the path indicated, and the flow through the elutriating apparatus had to be continuous and uniform. Steady suction [available in the laboratory] was used to maintain circulation in the unattended apparatus. How? [No mechanical moving parts required.]

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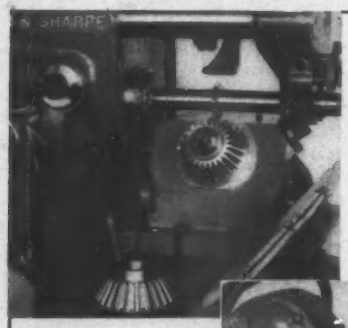
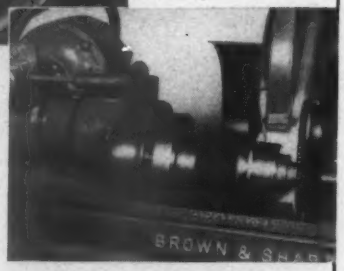


Left—Gear for retractable landing gear efficiently milled on No. 12 Plain Milling Machine.

Right—Accurately sizing base of cylinder on No. 20 Plain Grinding Machine.



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THE TABULAR VIEW

Belligerent. — Preparing for the national defense is a task to which institutes of technology have specific responsibilities, which in this issue of The Review are analyzed from the point of view of the social scientist (page 107). BERNARD BRODIE, whose discussion of the subject is at once thoroughgoing and provocative, is at present engaged in research at the Institute for Advanced Study in Princeton, as a holder of a Carnegie Corporation fellowship. Dr. Brodie is the author of a volume soon to be published by the Princeton University Press under the title *Naval Inventions and World Politics, 1814–1918*. This is the outgrowth of graduate study at the University of Chicago.

Stop Press. — Most intense expression of the problems of high-speed mass production is probably to be found in the metropolitan daily newspaper plant. Here, consequently, is one of the most prolific opportunities for engineering to show what it can do by way of producing economies and improvements in procedure. Yet in spite of the surprisingly wide range of specialized knowledge needed by newspapers — from optics and electricity through chemistry to mechanical engineering — only in comparatively recent years have engineers become part of the fourth estate. Technology men were pioneers in the field; the general demands to be met and the extent to which engineering knowledge and methods can be applied are described for Review readers (page 111) by GEORGE E. DONNELLY, '36, who as assistant to the superintendent of the New York *Daily News* speaks from full acquaintance with present necessities.

Lucky for Us. — Mankind is the recipient of some bits of good fortune so vital that they are not noticed by the ordinary observer. However, CECILIA PAYNE-GAPOSCHKIN, who has been on the staff of the Harvard Observatory since 1927 and Phillips astronomer there since 1938, discusses (page 116) as no ordinary observer the business of living in the cosmos. Her interpretation of the two-party transaction involving man and the cosmos hence is both invitation and guide to reflection. The essay is drawn from Dr. Gaposchkin's recent lecture to the Technology chapter of Sigma Xi.

Video. — Closely in touch with the art through his activities as managing editor of *Electronics*, DONALD G. FINK, '33, reports in this issue (page 114) on developments in the bringing of television broadcasting nearer to standardization and stability. Interesting as presaging recreation for thousands of folk, the efforts which he describes are of even greater significance in their demonstration of the co-operation of which an industry is capable.

Cunningham's. — LORING ANDREWS, who comments on cometary news (page 103), has been a teacher of astronomy at Harvard and Radcliffe and has served as program director of the Boston station of the World Wide Broadcasting Foundation.

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MAIL RETURNS

Letters Requested

FROM WILLIAM C. DICKINSON, '70:

I have received your November issue, and it certainly is a dandy. You are to be heartily congratulated for the very fine work shown in this publication. From some experience I know it is a big job to edit and have printed such an extensive book as you have produced in the best of style. I notice that you refer to Professor Richards of the first Institute Class — 1868 — who must be a man of quite advanced years. . . . For myself, of the Class of 1870, I was ninety-one on September 20 and at present can recall the names of Archer, Orvis, Cross, Mason, Turner, Whitney, and Herreshoff. I should be glad to hear from any of my Class who are still alive. My address is 5929 Cates Avenue, St. Louis, Mo.

I am the author and publisher of the enclosed two booklets [dealing with religious and philosophical subjects], and I have already supplied the Technology Christian Association with some hundred copies of each. . . . I am very much interested in everything connected with the Institute and always attend our Technology Club dinners. I wish you all success with your fine publication and expect to continue to support it.

St. Louis, Mo.

Clad, Not Plated

FROM CLAYTON D. GROVER, '22:

. . . I was a little disturbed at the mention of the nickel-plated holds in the fishing trawlers described in Richard Hallet's article, "Net Returns from the Banks," in the December Review. Actually, the proper description is nickel-clad holds. Nickel plate connotes the product with which we are familiar on electrical fixtures, and so on, whereas the material used in the holds of the trawlers is quite a different one. It is a composite heavy sheet or plate composed of steel with a layer of rolled pure nickel on one or both surfaces, the nickel layer being upwards of 1/32-inch thick. The product is made by the Lukens Steel Company by forge welding a slab of pure nickel to a slab of steel and then rolling it out to the desired thickness. The forge welding is accomplished at the rolling temperature by the initial pass of the composite slab through the roll. The material is fabricated and welded by a technique similar to that used for other materials. In other words, the term "nickel plated" conveys an idea of flimsiness, whereas the nickel-clad material is strong and husky.

New York, N. Y.

A Suggestion

FROM DONALD MCC. STURZNICKLE, '28:

A statement in Alvar Aalto's article, "The Humanizing of Architecture," in the November Review impels me to make a suggestion. The statement (on page 36) is: "Bright reflection from book pages is one of the most fatiguing phenomena in reading." The suggestion is: Please plan to use a less glossy paper for The Review, even at some sacrifice in photographic clarity.

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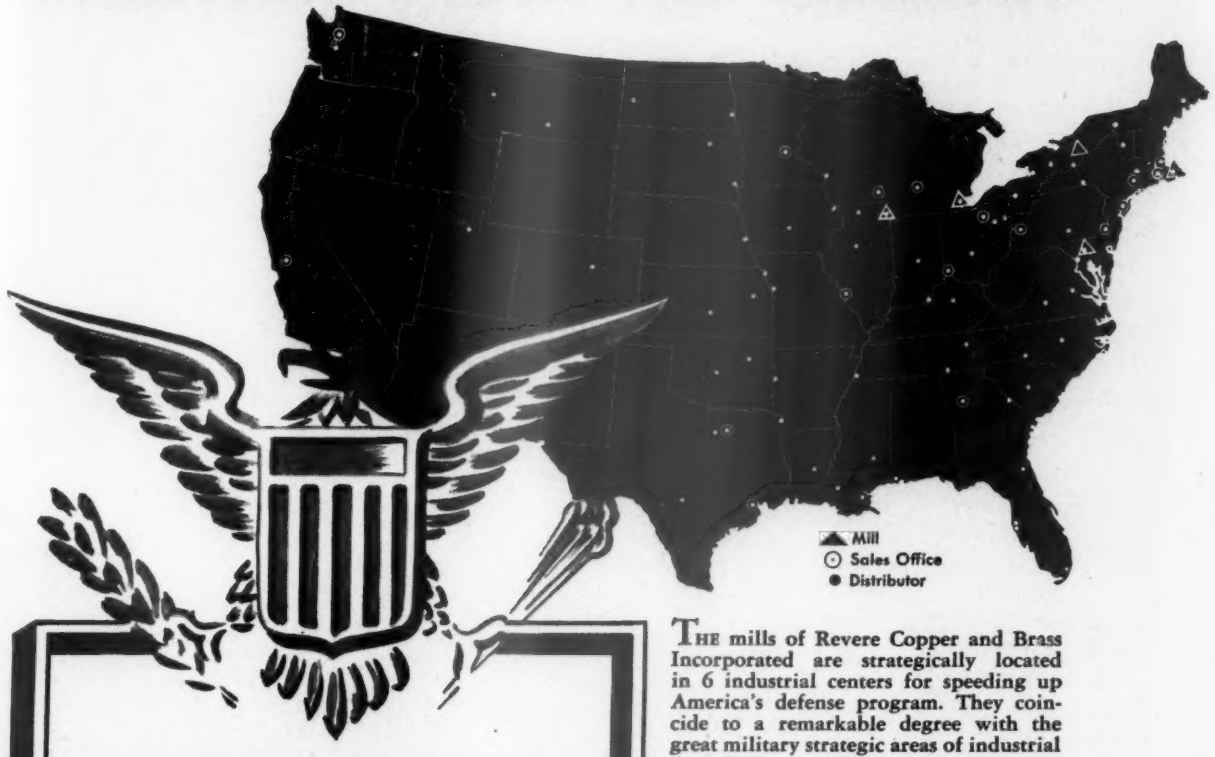

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VOLUME 43 NUMBER 3

THE TECHNOLOGY REVIEW

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AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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From a photograph by Charles S. Martz

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Flowing Metal

THE
TECHNOLOGY
REVIEW

Vol. 43, No. 3 January, 1941

The Trend of Affairs

Refrigeration Up to Date

ONLY a few years ago, milk was poured into shallow pans to cool on the hard, damp earth in farmhouse cellars. Butter was packed in dun glazed crocks and gently lowered into the cold water of the spring. Vegetables were buried in root cellars, and housewives fretted over hot stoves canning beets and beans and fruit. Meats were smoked, pickled in barrels of brine, or boiled and sealed in jars against the unreasoning demands of winter appetites. Even after the ponds gave up their ice when the household refrigerator came into general use, diets — particularly in the country — were limited, and the question, winter or summer, was, "Will the food keep?"

The milk pan has disappeared from the cellar floor, and fewer mice now die by drowning; the spring in the meadow no longer serves as a refrigerator; and vegetables are free of the musty flavor of the root house. Beans and beets and fruit are still being canned, but fresh vegetables are available to those who desire them. Even cider, the enjoyment of which was once the most exciting of rural adventures, is protected against fermentation, but refrigeration cannot be blamed for that.

Commercial cold storage, domestic mechanical refrigeration, and quick freezing have answered for all time the question, "Will it keep?" Seasonal restrictions on foods have largely been removed, and well-balanced diets are now available throughout the year.

Like many other advances in science and engineering, improvement in the storage and preservation of food has been taken for granted. Now, however, the increasing fury of the most destructive war in history focuses attention on the enormous importance of refrigeration and its biological significance, for when blockades close normal channels of trade, protection of accumulated food stores is vital to every nation.

The extent to which the peoples of the world are dependent upon refrigeration for preservation of their food materials is shown in a report just issued by the committee on biology of the American Society of Refrigerating Engineers. Bernard E. Proctor, '23, Associate Professor of Food Technology at the Institute, is chairman of the committee, whose other members include Gerald A. Fitzgerald, '23, and Milton E. Parker, '23. The report, "Recent Advances in Refrigeration Biology," brings news of the problems of food protection in England and on the Continent under war conditions and reveals not only that people are issued gas masks but that cold-storage food warehouses are equipped with air-conditioning scrubbers to remove the poison gases of war from incoming air.

In England gas-tight steel chambers for refrigerated storage of eggs in carbon dioxide have been provided to assure safekeeping of this important food. War has also brought into use in England a refrigeration apparatus specially devised to store human blood for emergency purposes at temperatures between 34 and 38 degrees Fahrenheit. The secret of the success of the apparatus is said to be the prevention of even the slightest amount of shaking, thus allowing undercooling of the proteinaceous bodies without denaturation.

In this country numerous reports have appeared in medical literature on the use of refrigeration in the treatment of diseases. The best that can be said at present is that refrigeration has been shown to be helpful in relieving pain; any other benefits in low-temperature therapy are yet to be demonstrated. The use of air conditioning in hospitals, however, has improved the comfort of patients.

Refrigeration has been a boon to the florist for many years. Before the present war one of the largest uses of carbon-dioxide ice in Holland was to lower the temperature of flowers shipped by airplane to the big cities of

Europe. Gladiola blooms have recently been quick frozen and stored in this country. What the development may mean to floriculture depends on how many other flowers are capable of similar treatment.

Food poisoning caused by staphylococci has been much more common in recent years. Although no relation has been indicated between this disease and frozen foods, it is of interest that Canadian scientists have demonstrated that staphylococcic poisoning cannot come from frozen foods which are thawed and kept below 50 degrees Fahrenheit before cooking.

Ice containing small amounts of nitrites has recently been advocated by Canadian authorities for use in the fishing industry and has been cited as beneficial for the packing of cod and salmon. The ice is not applicable to halibut because of a resulting discoloration. Investigations relating to the possible use of hydrogen peroxide in ice are now being carried on in this country.

Presse-Photo from Black Star

Order — finished gears being readied for assembly

The recent discovery that ground peanuts release their oil content much more readily if subjected to freezing may lead to elimination of the use of heat treatment in producing virgin oil.

The value of carbon dioxide as an adjunct to the refrigeration of fruits in storage and in transit becomes more and more evident. Carbon dioxide has proved particularly helpful in extending the storage life of peaches, plums, cherries, and pears in long-distance shipments. Precooling of fruits and vegetables is definitely on the increase, and hydrocooling for such products as celery and broccoli has become more widely appreciated as a conservation measure before long shipments are started. The need for treatment as soon as possible after harvesting is also better realized. A few hours at that time may be the equivalent of as many days in the total storage life of the product.

Sulphur-dioxide fumigation of grapes before refrigerated shipment or storage has proved beneficial in lowering the incidence of molds and rots but does not appear applicable to other fruits unless a different gas is used, since sulphur dioxide injures many fruits.

Various kinds of nuts are refrigerated to prevent insect infestation. Pecans have been found to be particularly sensitive to ammonia, as low a concentration as .01 per cent causing discoloration. Almonds are less susceptible, and walnuts are affected comparatively little.

To destroy the cigarette weevil, which frequently infests tobacco, refrigeration has been found very useful. Restricted exportation of tobacco during the past year has caused the refrigerated storage of it to increase tremendously, as no damage by weevils will occur at the lower temperatures.

According to estimates, about 600,000,000 pounds of frozen foods were produced in 1940, with some 3,200 cold-storage locker plants handling 250,000,000 pounds of products from the farms of our country. Farm freezers are being purchased in considerable numbers, especially in areas where public refrigeration is lacking. These trends seem to indicate that refrigeration is now appreciated to an extent which a decade ago would scarcely have been believed. The health of rural populations, for whom well-balanced diets have been rare in the winter, will be vastly improved by facilities which enable them to enjoy their own meats and vegetables during off seasons.

The proper control of the vast stores of frozen foods is a matter of great importance from both the standpoint of health and that of economics. If proper temperatures are maintained and the foods are of good quality before being frozen, no difficulties are likely from a health standpoint. Microbiological tests, by helping to determine the quality of food, perform a useful role although they are not the sole index of quality. Vitamin content, which is also a factor in quality, has an important role in the health-promoting qualities of foods and is becoming another yardstick useful in evaluating the care with which certain foods have been handled previous to being frozen.

The proper protection of foods in storage has become so important that new packaging materials, containers, and packaging methods have been evolved to combat dehydration and the resulting deterioration in appearance and flavors which may occur simultaneously. To be of the greatest protection against dehydration, packaging must be secure against moisture vapor and capable of an absolutely tight seal.

Certain changes in the form in which foods are offered to the public have also appeared. Eviscerated poultry and cut poultry will soon be the rule rather than the exception. Frozen eggs have practically replaced shell eggs for commercial uses. Frozen cream, deaerated before being frozen, is common, and frozen sweet-cream butter is one very satisfactory means of storing fat.

Refrigeration in America is helping in the solution of many problems of food preservation, and its potentialities for maintaining the health standards of the people in case of a national emergency constitute one of the most reassuring prospects of preparedness in the Western Hemisphere.

The Strait and Narrow

ACCORDING to the observations of a hospital situated near a transcontinental highway in rural New York, the safest driving conditions are in foggy weather on snowy or icy roads with many curves and intersections. Thus again is pointed out the principle about which revolved the article "Motor Necrology" in the December Review.

Speed is the greatest cause of fatal accidents. Most automobile injuries (over 80 per cent) treated at this New York hospital occurred in cars going straight ahead; many of the accidents did not even involve collision with another car. A large proportion of them did not occur under difficult driving conditions but on open country roads in clear, dry weather, and more frequently on summer week ends than at other times. Many of the injuries were serious, the average stay at the hospital being practically three weeks.

Enlightening also is the knowledge that metropolitan New York, with 55 per cent of the population and 60 per cent of the accidents, has only 30 per cent of the fatalities; whereas rural New York, with 15 per cent of the population, has 40 per cent of the fatalities. As the report bleakly concludes: "Excessive speed and lack of acquaintance with the hazards of the open road are responsible for most automobile accidents on rural highways."

Comet in the West

BY LORING ANDREWS

REACHING its greatest brilliance early this month, Comet Cunningham, which became visible to the naked eye in December, is the first comet worth crowing about since 1910, when two, one of them Halley's, blazed in the sky. At the time it first became discernible, the new comet's head lay about halfway between bright blue-white Vega, dipping low in the Northwest, and less bright Altair, equally low in the West. When maximum brilliance is attained, the head will have moved to the left and below Altair. The comet's tail will stretch each night to the right, or northward, almost parallel to the horizon.

Just how bright the comet will be and how long a tail it will have early this month are matters for speculation. Astronomers are predicting that its greatest brightness will rival that of the planet Jupiter, which now graces the southern quadrant of the sky each night. As for the tail, the fact that the comet already possessed one when discovered augurs a tail of great extent, rivaling that of Halley's comet.

As usual, the astronomers were the ones who received the advance notices of the forthcoming attraction. Leland E. Cunningham of the Harvard Observatory took over the coveted role of producer's representative. Poring routinely over an astronomical photograph taken by the observatory on September 5, he came across the comet's imprint amid the host of star images. Like most cometary discoveries, this one was an accident. The finder has already received the customary reward — the comet has been named for him.

When it was discovered, nothing was known about the comet except that it was so faint that only a telescope could make it visible. But word went around, and several observatories immediately set to work to photograph the newcomer from night to night, recording a permanent history of its life. Give astronomers a few days to accumulate evidence, and a comet's travels are no longer a secret.

Cunningham's comet probably started its journey earthward and sunward shortly after the fall of the Roman Empire, from a point approximately fifteen billion miles away — a distance more than eleven billion miles beyond the present outer boundary of the solar system defined by the orbit of the planet Pluto. For centuries the comet dawdled in the outer reaches of the solar system and beyond, slowly accelerating under the sun's gravitational pull, until, at the time of its discovery, the comet was flying high over the orbit of Mars at the lazy cosmic speed of thirteen miles a second. As it approached naked-eye visibility, the comet swept in, from above and behind, upon an earth retreating along its orbit about the sun.

In mid-November, the comet passed sixty-five million miles above that point in space vacated by the earth on October 1. At present it is dipping rapidly downward to pass almost exactly between the earth and the sun on January 19, when it will be sixty million miles from the earth, thirty million from the sun. This distance represents the comet's closest approach to them. Immediately thereafter, it starts its return journey toward the outer reaches of the solar system and beyond, during which it will be visible only to viewers in Southern latitudes, but only before sunrise and only until the end of the year.

If all goes well, Comet Cunningham will be back in the earth's vicinity sometime after the year 4,000. The comet's last

Victor de Palma from Black Star

Chaos — scrap awaiting ultimate re-use

John H. Gerard

A South American vulture in the St. Louis Zoo

appearance was probably about the time Archimedes was crying "Eureka." These two predictions verge on guesswork, but there is a fair chance they will be verified before the comet disappears from view.

No show is perfect. Although this one is going to be great while it lasts, it is not going to last quite long enough. The comet will not be visible when it is at its brightest and its tail is longest. These phenomena occur together when a comet reaches its closest approach to the sun, its perihelion passage. Cunningham's comet at perihelion passage on January 19 will be almost on the line joining the earth to the sun. Its tail, could it be seen then, would lie end on, as it trails back from the comet's head toward the earth. So the curtain will fall about January 6 as far as Northern Hemisphere observers are concerned.

Before the age of science, comets were awesome affairs, as the records of history show. Their very unpredictability and uniqueness of appearance clothed them in vestments of mystery and supernaturalism. When, beginning in 1750, astronomy began to write its version of the cometary story, comets ceased to be mystic auguries of war, of famine, of pestilence, and of other ills. Anything shown to be amenable to the dictates of natural laws loses its supernatural reputation.

The first discovery was that, like planets, comets were members of the sun's family; that they, too, moved in elliptical orbits about the sun, though taking hundreds, even thousands, of years to complete the journey. Further study has revealed the internal character of a comet. The head has been pictured as a transparent sphere of highly rarefied gas impregnated with small, solid particles. Here the adjective "small" covers a range of sizes from large boulders to specks no bigger than dust. While a comet may be a hundred thousand miles in diameter, larger than the largest planet, the amount of solid material it contains is less than that composing the smallest planet. By human standards, however, the amount is enormous.

The relation, other than gravitational, between a comet and the sun has been but partially resolved. Unquestionably, the light of a comet is in part reflected sunlight and in part a sunlight-impelled self-luminosity of the gaseous material. Clear also is the fact that sunlight, by causing disintegration of the solid material and exerting pressure upon the resulting debris as well as upon the other smallest ingredients of the head, motivates the formation of the horn-shaped tail. Since the magnitude of the effects depends on the intensity of the sun's light, maximum brightness and maximum length of tail usually occur at the comet's perihelion passage.

The story of comets from the scientific angle is far from finished. Like laymen, astronomers take bright comets to their hearts. Faint comets occur in abundance, but bright ones are usually once-or-twice-in-a-lifetime affairs and, as is true of other *rarae aves*, deserve attention.

The Widening Eye

BY reason of a truly superhuman versatility, which permits it to gaze unblinkingly into a furnace, react to radiations lying far beyond both ends of the visible spectrum, imperturbably note every detail of a scene in 1/100,000 second, and then produce a record of the event which can easily outlast the men who view it, the camera is used in virtually every field of science and industry. At the first International Exhibit of Scientific and Applied Photography, held in 1937, were photographs, for example, of medical subjects, national disasters, ancient documents, the aurora borealis, and the interior of gun forgings; pictures made with gamma rays, x-rays, ultraviolet rays, infrared rays, and the various colors of the visible spectrum; others made with the aid of microscopes, telescopes, spectrographs, and oscilloscopes. According to the sales statistics, commercial and professional uses (including, of course, many which are nontechnical) require twenty-five to thirty million dollars' worth of photographic supplies and equipment a year, which is less than the amount amateurs consume but more than the amount the moving-picture industry spends.

As C. E. Kenneth Mees pointed out recently at a meeting of the Optical Society of America, some notable improvements have occurred in the past fifteen years to extend the art of photography. Surveying the entire field, Dr. Mees was particularly impressed with the rise of amateur cinematography, the increase in the number of persons doing their own developing and printing, and the recent achievements in color photography.

Changes of importance to the utilitarian applications of the still camera include the creation of many new sensitizing dyes for film emulsions, the rise of small, precision-built cameras with fast and highly corrected lenses, the marketing of photoelectric exposure meters, and the production of many new light sources of increased performance and convenience.

Hundreds of dyes are now available which will increase the sensitivity of film emulsions to one or another color ranging from violet far into the infrared

spectrum. In the latter region, for example, the di-, tri-, and tetracarbocyanines permit emulsions to react to wavelengths up to, and beyond, 11,000 angstrom units (the visible spectrum extends from 4,000 angstrom units in the violet to 7,000 in the red). While the infrared region is as yet of significance mainly to special fields like spectroscopy, all photography has benefited from the fact that there are now available many fast, fine-grained emulsions sensitive to colors according to their relative brightness as seen by the eye. The characteristic of fine grain combined with considerable speed — made possible by the ability of certain of the dyes to increase speed as well as color sensitivity and to affect fine-grained emulsions proportionally more than they affect inherently faster coarse-grained types — is a contributing factor in the rise of miniature cameras, for their tiny negatives must be enlarged many times in order to give prints of normal size.

If the new panchromatic and color films represent a remedy for one of the camera's deficiencies (its former blindness to color), the lenses of wide aperture now found on miniatures and the more powerful light sources are at least palliatives for another — its relative insensitivity to low levels of illumination. One manufacturer offers eight varieties of photoflash lamps and seventeen lamps for color photography; there are also, of course, the single-flash lamps developed as part of the stroboscopic technique. The miniature camera in combination with the single-flash lamp is becoming virtually a routine tool in the study of rapidly moving machine parts and other transient phenomena. At least two forms of single-flash lamps operating for about 1/30,000 second a flash are now offered commercially, and several stock emulsions especially adapted to the spectra of such lamps have been made available.

Not to be overlooked in the development of these devices and in their technical applications is the influence of the great amateur market, sharing development costs and stimulating the evolution of simpler and more reliable techniques for the man behind the view finder. Many an application has grown out of a technician's interest in photography as a hobby, and the transition is the less difficult because much amateur equipment is now easily good enough for the demands of the laboratory.

Bombs That Blaze

PEACETIME living has taught humanity that nothing can be more devastating than a sweeping conflagration. It is only natural, therefore, that men should constantly make use of fire in devising more efficient weapons with which to destroy their fellow men. A discovery of the World War was the flame thrower. A discovery of the current war has been the apparently effective incendiary bomb. Although two types of incendiary bombs were used during the last war, each failed of its purpose because the principal ignitable material burned itself out too rapidly. In one, thermite was the incendiary material; in the other, some flammable liquid, such as gasoline, was used. Incendiary bombs developed for use in the present war are again of two types and are known popularly as electron bombs and multiple-effect bombs.

The electron bomb consists of a shell of electron metal (80 per cent magnesium and 20 per cent hardening metal), inside which is a charge of thermite. Unlike the former thermite bombs, however, in the electron bomb the magnesium shell and not the thermite is the principal incendiary material. Upon impact, the thermite is ignited by mechanical means and burns at a temperature of about 3,000 degrees centigrade for fifty seconds or more, by the end of which time the magnesium shell has been ignited. The shell then burns for ten or fifteen minutes at a temperature of approximately 1,500 degrees centigrade. With the exception of the igniter and the tail, which is made of sheet iron, the bomb is composed entirely of incendiary materials, and hence is more efficient than explosive and other kinds of bombs.

Electron bombs range in weight from one kilogram to twenty-five kilograms. The penetrating power of the lightest of these bombs, however, is not very great, and since they cannot be dropped with any degree of accuracy, they are used for indiscriminate bombing. Such small bombs will pierce only four inches of reinforced concrete, six inches of sand or earth, or a quarter of an inch of steel plate. Because they are awkwardly streamlined, they reach a maximum velocity of approximately 350 feet a second after they have dropped about 5,000 feet. They are not dropped singly but in lots of ten or twenty from containers within the bombing plane. The contents of more than one container can be released simultaneously. Ten or twenty bombs let loose at the same instant from a height of a mile or more will strike anywhere within an area of 10,000 square yards. Heavy electron bombs, on the other hand, are used against specific objectives, such as power plants, munition dumps, and factories. To increase power and accuracy, heavy electron bombs are fitted with steel noses.

A zone-tailed lizard, American Museum of Natural History

American Museum of Natural History

Though a single bombing plane can carry as many as 2,000 one-kilogram bombs, 2,000 fires will not necessarily be ignited. It has been estimated that only 15 per cent of an urban area is built over. If, therefore, 2,000 bombs are dropped, an average of 300 will strike the roofs of buildings. Of these 300, 50 per cent will either glance from the roofs or fail to penetrate because of the roof construction. The remaining 150 can set fires.

Although the electron bomb itself is difficult to extinguish, several methods have been discovered to combat it and to stop the spread of its fire: One is the use of a fine spray of water. Although water accelerates the burning of magnesium, the mere fact that the burning is increased also means that the bomb will burn itself out within two or three rather than within ten or fifteen minutes. The fine spray also serves to wet down the area surrounding the bomb, so that the fire will not spread. Powdered talc, dry sand, or other such granular materials can likewise be used to combat the electron bomb by smothering it. The bomb cannot be smothered while the thermite charge is burning, however, because the oxygen required for the reaction comes not from the outside atmosphere but from the iron oxide of the thermite. To smother the electron bomb, there has also been developed in England a device called a "snuffer," made of wire mesh sprayed and covered with asbestos. Ordinarily, a minute is required to smother such a bomb.

The multiple-effect bomb contains separate incendiary units which scatter over a wide area upon impact. These units are either magnesium, phosphorus, or both. Those of magnesium are combated as are electron bombs, and the units of phosphorus can be prevented from burning by being placed in water. Multiple-effect bombs weigh approximately twelve kilograms and are used in the bombardment of specific objectives.

Deep-Sea Oil

IT seems difficult to find a dull book about whales. They are creatures of such miraculous metabolism and such fantastic proportions that a mere listing of zoological data takes on an *Arabian Nights* flavor. The midget whale, for example, is so called because it grows to a paltry maximum of 20 feet; on the other hand, a really big whale, like the blue variety, may exceed 100 feet in length and 150 tons in weight, the equivalent in living tissue of perhaps two thousand men. To approach sexual maturity and about 75 feet in length, as they do in less than two-and-a-half years of adolescence, young blue whales grow (during their suckling period) at an *average* rate of 220 pounds a day. With meat, bones, blubber, and organs containing oil, these mammals are small-scale oil wells; one blue whale weighing 122 metric tons yielded 27.7 tons of oil.

In *Whale Oil: An Economic Analysis*,* the author, Karl Brandt, quite logically introduces such biological data because they are, in the end, the factors which limit the importance of the whaling industry. The baleen whales of the Antarctic, which are the backbone of the industry, must leave the icy seas, where food is plentiful and where they grow fat, and migrate into warmer waters in order to bear their young, which could not at first survive near the ice pack. This annual migration must be respected by the whalemen if whales are not to be destroyed with little return in oil. The fact that the baleen whales are monogamous and appear to show a tribal adherence to certain areas restricts the catch that can be taken year after year from a given region. "It seems beyond doubt," says Brandt, "that the world's stock of blue whales [the largest and most desirable species] has in recent years been overtaxed," a not surprising conclusion in the light of the unparalleled numbers of animals which the modern whalers are taking (see The Review for last June, page 316).

The fear that the whalers are killing a goose laying golden eggs has long haunted the whaling companies as well as their governments. Brandt feels that international agreements and national legislation aimed at controlling the whale fisheries, while definitely a net gain, have been at bottom unsuccessful, mainly, it is true, for reasons beyond control, with the world situation as it has been for the past decade. The only way, he believes, to guarantee the existence of herds large enough to support an industry approaching the present one in size is to limit the total seasonal catch. He cites the encouraging results of that method on the United States–Canadian halibut fisheries and on the herds of fur seals on the Pribilof and Commander islands. [It is to be regretted that the latter illustration may soon be obsolete. Japan several months ago denounced the treaty in which it had been associated with Russia, Great Britain, and the United States for the protection of fur-bearing seals. — Ed.]

Paul J. Woolf

The angularities of urban winter

In its basic features, modern whaling clearly shows its descent from Nineteenth Century whaling. The new fleets still hunt in the open sea, a flock of (*Continued on page 133*)

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Defense and Technology

Specific Problems for Technological Institutions Are Posed as the Nation Proceeds with Its Preparedness Effort

By Bernard Brodie

HOW can our colleges in general, and our technological institutions in particular, aid the national community in the collective enterprise now before it — that of best and most quickly preparing our defense? To what problems of defense ought our faculties to devote their minds and their research facilities? What is it important that our young graduates know? What, in other words, is the role of the student, the scholar, and the research scientist in promoting this essential aspect of the public welfare? Should they be "conscripted" into such a collective endeavor at the cost of disrupting the continuity of their usual pursuits and of violating our justly cherished tradition of academic freedom, which includes freedom to pursue scientific interests untrammeled by official dictate?

Successful resistance to totalitarian aggression requires, if not totalitarian defense, at least defense on a scale far larger than we have yet brought ourselves to understand. The magnitude of our resources and our relative geographical isolation render extremist measures unnecessary — these, indeed, would defeat our purpose [1, *] — but we cannot depend too much on either of those factors. Complacent reliance on our potential strength is potentially disastrous. And we must dismiss all notions of complete "business as usual." A measure of defense preparations designed only to take up the slack in our industrial productivity will surely not suffice.

The issue of whether our research talent ought to be conscripted for the necessary investigations can be dismissed as purely academic. Great Britain, after more than a year of war, has in this respect encountered no difficulties: With a well-organized and constantly developing system of intellectual co-ordination, in which problems are turned over by a Scientific Advisory Committee to those regarded as most competent to deal with them, the question of compulsion simply does not arise. In our country, faced by the possibility but not the actuality of war, the impelling necessity is not so conspicuous. But our scientists will not remain insensible to the public need, once that need is clear. Similarly, we need waste little concern about disrupting pursuits of more enduring interest than current war. With war as endemic to present society as disease is to our physical beings, it is time that scientists, particularly political scientists, ceased contenting themselves with the periphery of the subject and examined the subject itself. Our political scientists have approached the problem of war with the technique of the medicine man rather than of the physician and have sought to prescribe cures without troubling to study the disease.

The program for our preparedness effort involves the utilization of talent in all scientific disciplines. Our whole industrial and economic order must be scrutinized anew with an eye to the needs of defense. The psychological preparation of the population for the tasks before it and the attacks likely to be made upon it must be examined. The strategy of national defense should be studied not only by the handful of military and naval officers to whom it is at present solely entrusted but by all the civilian competence that can be marshaled to the task.[2] The place of Great Britain and other potential allies in our welfare must be resolutely established. Above all, the conciliation of democratic processes with the exigencies of defense preparation and even the conduct of war must be achieved. The proposition that to combat fascism effectively we must surrender our democratic liberties and therefore become largely fascist ourselves is, of course, intellectually crass and untenable, but the existence of a great problem of transcendent importance is thereby indicated.

From this broad point of view it is clear that the technological colleges are not the only institutions of learning with a task to fulfill in the current program. But no one can seriously contend that the role of technology is secondary. Despite the indisputable effectiveness of the nonmilitary weapons of the dictators, the decisions of today that affect man's destiny are those reached on the battlefield. This destiny the technologist influences by providing, or at least offering, new weapons by which decisions may be won, just as he has influenced man's destiny during more tranquil times by transforming the physical basis of civilization. The role of the technological institution in the present crisis is thus primarily the promotion of the study of present methods and possible new means of waging war.

The term "defense" has been used several times in the foregoing paragraphs in the euphemistic sense customary in English-speaking countries, that is, to denote ability to wage war. That it is better to wage war offensively than to have to remain on the defensive may be platitudinous, but considering the tenor of much of our political and public debate, insistence on the point is still necessary. If this country should unfortunately be forced to take to arms, our objective should be not merely to win the war but to win it with the minimum expenditure of blood and strength — to win it in the shortest possible time by means of an overwhelming offensive. Such an end would be sparing of our enemies as well as of ourselves and thus all the more to be desired. Our plan should therefore be not to hold our own in a war of attrition but to attain at the earliest possible moment a decisive superiority.

* Numbers refer to bibliography at the end of the article.

Superiority is achieved in many ways — through greater shrewdness in tactics and strategy, through superior morale, through greater quantity and superior quality of men and weapons. The technologist is concerned primarily with the last of these items — the quality of the weapons.

As Major Victor Lefebure has pointed out,[3] one of the significant differences between the Nineteenth Century and the Twentieth Century in the preparation for, and the conduct of, war is the rigorous secrecy imposed upon the development of new weapons in our time. The degree to which concealment was neglected during the Nineteenth Century frequently reached what to the present-day mind seems almost comic-opera proportions. John Ericson once wrote a letter to the London weekly, *Engineer*, in which he asserted, in indignant protest against an allegation to the contrary, that the *Monitor* had been constructed under the most open circumstances possible, that it had been built in a shed to which anyone who wished had been admitted. We may presume that anyone wearing the uniform of the Confederate armed forces would have been detained at the entrance, but the implication of the letter was that all others were received with the greatest courtesy.

Not merely was there a complete absence of concealment during the Nineteenth Century but the private armament firms were privileged, and even encouraged, to peddle their latest wares on an international market or to distribute to factories abroad on a royalty basis the process of fabrication and the right to manufacture some possibly revolutionary weapon. Thus, the Krupp new process armor, which at the time of its appearance in 1895 completely changed the ballistic standard, was by 1898 being applied to new ship construction in all the navies of the world. Purchases of this armor by the United States Navy were from the Bethlehem and the Carnegie steel companies, which had obtained the process and the license to manufacture the armor. Since the process was a very involved and difficult one, it might easily have been kept secret.

Such absence of secrecy meant that disparity in equipment tended to be one in quantity rather than in quality, and that surprise in the use of new weapons was contingent upon official stupidity of such magnitude as to refuse comprehension of the obvious. For example, the main tactical factor aiding the Prussians to defeat the Austrians so overwhelmingly at Sadowa in 1866 was the needle gun, which had been invented a full thirty-one years before. It had been adopted by the Prussians by 1851 and had been used successfully by them when they had been allied with the Austrians against the Danes in 1864. King William's delight with the gun had been so great during the Danish war that he had ennobled the inventor. The Austrians had had every opportunity to observe its advantages and to adopt it, but they had failed to do so.[4]

In contrast, the rigid secrecy of today in the development of weapons means that a great power, by concentrating its scientific competence on the development of some new type, can very likely assure itself of decisive superiority. In the War of 1914–1918, several new and secret weapons, like poison gas and the tank, might have yielded a quick decision at their first appearance had their full potentialities been recognized by their initiators. Also, the submarine, a pre-War invention whose potentialities were recognized only during the conflict, might in 1915 or 1916 have achieved the decision it failed to win in 1917.[5] To be sure, the resourcefulness of organized espionage must be reckoned with, but by and large the opportunities of surprise in character of armament have steadily grown.

From a detached, objective point of view, this is very unfortunate. It is a factor weighting the scale of international politics toward even greater instability. But as an existing condition it should be considered in our plans for defense. Our aim in rearming should therefore be not to match gun with gun but to match gun with a vastly superior type of gun or with something entirely different and overwhelming in its effects. To provide such is obviously the role of the technologist and of the institution which harbors him.

This idea opens up what to many appears an appalling vista of unrestrained competition among the world's best scientific brains to devise new and ever more horrible instruments of death — truly the lurid end of a civilization that might have set itself to better things. Perhaps so; but war is a phenomenon long since invented and today very much with us. Effort on the part of those menacing us must be matched with effort of our own. Weapons by themselves have not produced war, nor is there any convincing evidence that conflicts have become more bloody with the refinement of the instruments with which battles are waged. When armies had nothing but the highly erratic smooth-bore musket, they obligingly approached nearer each other and remained more exposed during the action than did later armies with their accurate rifles and machine guns. Researches have shown that the naval engagements of the old wooden-walled sailing ships were probably more destructive to personnel in proportion to the number involved than are those encounters which occur under modern conditions.[6]

If nations have become more stubborn in their struggles, if wars of attrition have become more exhaustive, the reasons may be as much sociological as technical — though under "sociological" must be included all the changes in our society resulting from advances in the mechancial arts of peace. But it should not be overlooked that perhaps never before has a great army been so decisively destroyed as an effective military force with as proportionately small a loss of life on the part both of the vanquished and of the conqueror as the French army in the spring of 1940. Whatever conduces to a quick decision may be held to save life. On the other hand, it must be admitted that it may also make war more likely.

The whole question does bring up the traditional reluctance of the military profession to be killed by anything but traditional weapons. The first submarines used against enemy warships during the Napoleonic Wars and the War of 1812 elicited the universal execration of naval men, who, as Admiral David D. Porter later put it, "preferred the more chivalric method of sinking vessels with eighteen and twenty-four pounders, or mowing down their crews with grape and canister." When a civilization deems a weapon dishonorable, no

amount of ratiocination to prove the illogicality of the attitude in the light of the existence of war can overcome revulsion at the use of that weapon. Yet the world becomes inured to new methods of inflicting death or injury with surprising and perhaps tragic rapidity. If researches reveal new and apparently heinous methods of winning a decision in war, the appraisal of their advantages in the light of their supposed hideousness will require a good deal of intelligence and the weighing of many issues, including the necessity for living with the enemy after the war. Such researches cannot, however, await our resolution of that problem, for we cannot decide whether to use or avoid a new agent of war until we have discovered it and tested its properties. This kind of research and experimentation is what our institutes of technology are pre-eminently fitted to carry on.

A survey of the catalogues of the leading schools of engineering in the country strikingly reveals the paucity of courses devoted to the engineering of the implements of war. Except for a number of courses at M.I.T. and one or two at Stanford University, advanced courses specialized to this field are lacking, since those of the Reserve Officers' Training Corps departments are usually descriptive and elementary. Courses in "explosives" are offered in two or three chemical engineering departments, but the extent to which the courses are occupied with explosives of military utility is not clear. Of course, the admirably thorough training given in departments of mechanical, civil, chemical, and metallurgical engineering, and particularly in more specialized derivative fields like aeronautical engineering, imparts to young specialists a body of learning and a fund of techniques indispensable to war engineering and of immediate transfer value to it. The scientific and engineering training offered in this country is in quality and availability unsurpassed or even unmatched in any other country — a factor of no mean weight in the determination of our war potential. But as long as there is a lack of courses as specialized to war engineering as are "boiler design," "masonry structures," and "plumbing design" to their respective fields, the burden of research and development in war material will fall upon the few graduate engineers in armament industries and the small group of military officers who have the requisite technological training. Most of them are apt to be promptly burdened with specific tasks which obstruct a broad research outlook.

Why are courses in interior and exterior ballistics, armor-plate engineering, ordnance design, propellants, and chemical warfare so rarely offered in these institutions? The requirements of secrecy always obtrude themselves upon the conduct of such research. But, though the Army and Navy are already co-operating closely with at least several university chemistry departments, the great fund of specialized knowledge in war engineering which is already generalized internationally is not now accessible to the engineering student. The explanation is not in the hitherto small industrial demand for workers in specialized fields, for we find whole departments devoted to the study of such subjects as seismology and astrophysics. The reason doubtless springs from a sense of moral values, from a conviction that institutions of learning should exist to increase man's knowledge of his world and to develop and impart techniques designed to improve and multiply the means for a better life — not to destroy them and life itself.

This conviction is an old one among scientists. Niccolò Tartaglia, founder of the science of ballistics, kept to himself the results of his experiments in 1531 because he had decided that "it was a thing blameworthy, shameful and barbarous, worthy of severe punishment before God and man, to wish to bring to perfection an art damageable to one's neighbor and destructive to the human race," and that to concern oneself with such matters was a "grave sin and shipwreck of the soul." When an invasion of Italy by the Turks became imminent, however, Tartaglia changed his mind. "Today . . . ," he wrote, "in the sight of the ferocious wolf preparing to set on our flock, and of our pastors united for the common defence, it does not seem to me any longer proper to hold these things hid, and I have resolved to publish them . . . so that all should be in better state either to attack the common enemy or to defend themselves against him."[7] The

R. I. Boynton from F.P.G.

Legs of the cavalry — an army tank tractor

antipathy of scientists to the "prostitution" of their efforts in the further development of war instruments does credit to their humanitarian sentiments, but it is bound to collapse under the realization that "destruction" engineering may become really "conservation" engineering in its most meaningful sense — engineering calculated to produce those weapons by which the things we hold most dear in our civilization and in our national existence may be defended against attack.

Engineers, being for the most part conspicuously practical men, have tended always to realize somewhat more clearly than others that a gun is a gun, an inanimate object with no moral status, a material thing which can be used for a purpose, and that it is the purpose and not the thing which should be subject to ethical appraisal. Yet institutions of technology either have not shared this detached view sufficiently to incorporate studies of war matériel into their curricula or have bowed to a pacifist public opinion. When, for example, Sir John Siddeley, a well-known airplane manufacturer, contributed to Cambridge in 1935 the sum of £10,000 for aeronautical research, considerable controversy was provoked as to whether this was a contribution to war research; the authorities were constrained to deny that it was.[8] At this time, it must be remembered, no such controversies were arising in Germany. Pacifist feeling would be very good indeed if it could exist on the same high level throughout the world. Experience has shown that once the war crisis comes, scientists are the first to insist that their ingenuity and organization be utilized by the government in the national effort. The character of totalitarian war, however, necessitates an earlier change of heart among the scientific men of a country that is determined to resist aggression.

The curricula of our technological institutions have rightly undertaken to offer training in industrial management. The successful co-ordination of individual engineering effort is the essence of modern production. But the catalogues give no indication that attention has been paid to those problems which arise in production and management when the nation's economy must be geared to war rather than to peace. In war, the need is for the maximum production of a necessary commodity by all the industrial establishments suited for its manufacture. In time of peace, the individual entrepreneur's interest in the quantity of production is for that level which maximizes his aggregate profit. His efforts are bent always toward increasing that total profit rather than toward stretching his production to the uttermost. Competition under these circumstances tends to result, *in the long run*, in enhancing the efficiency of the individual factory as well as the quality of the product, but it also results in a great deal of waste through failure to utilize available resources wherever "unprofitable" — i.e., wherever the aggregate profit is diminished — and through excessive efforts to stimulate consumer demand, both of which are inimical to a war effort.

The technological colleges should, therefore, encourage investigation of, and training in, problems peculiar to the science of defense economy, a science which has already seen intensive development in Nazi Germany but which has been until very recently practically virgin ground to American economists. The Nazi regime inaugurated a professorship of defense economics at Berlin University as early as the spring of 1934, and since that time the German literature in the field has become enormous,[9] a fact to which several acute observers attach considerable importance in explaining the great German military strength of today.[10] Our purpose in stimulating similar study here would be not to emulate Nazi economy but to learn how best to adapt a capitalistic economy to various national emergencies without sacrificing either its enduring values or the possibility of reinstating it upon the return of more tranquil times.

A survey of curricula brings up another matter of some concern: Many, if not most, of the graduates of technological schools have acquired commissions in the Officers' Reserve Corps as a result of their R.O.T.C. training while in college. These men perforce enter into the cadres in that branch of the service represented by the particular R.O.T.C. unit at their college rather than in the one for which their training most suits them; in the event of a national emergency they would be called instantly into military service and away from those industrial pursuits where they would be of eminently greater value to the country. Not the least of the tragedies in France might then be repeated. In September, 1939, highly skilled workers were mobilized out of the French armament factories and sent to provincial barracks where the men were kept in semi-idleness; weeks and months were required to locate the workers again and send them back to the factories.[11] Even if that situation should not occur here, the fact that commissions are held by many men who are not really available for military service gives us a fallacious picture of our reserve-officer strength, and in the event of mobilization serious dislocation is likely to result. Civil engineers would be valuable in the Corps of Engineers, and some electrical engineers would be needed in the Signal Corps, but that chemical, mechanical, and aeronautical engineers should hold commissions leading them to assignment to 75-millimeter field guns is, to say the least, uneconomical.

On the other hand, though the wisdom of permitting engineers to hold commissions subjecting them to mobilization into nonspecialized services is questionable, their college military training should not be discontinued. It ought even to be intensified, and for the same reason, though in reverse, for which Major General J. F. C. Fuller of England would have his generals study mechanics: "A staff officer graduate . . . ," Fuller says, "must study modern engineering journals, and the old prints of hundreds of years ago depicting flamenwerfers and gas bombs; these will set vibrating brain-waves which will awaken new designs. He must study the evolution of weapons — in fact, he must become an adept in war tool biology. This is scientific preparation for war, the rest is one per cent."[12] The fact is, there is a good deal more substance to be vibrated on this subject in the mind of the engineer than in that of the general. Let the latter's mind be vibrated by contemplation of the instruments which the engineer produces so that the general (*Concluded on page 123*)

Newspaper Engineering

Demands of Readers for Speed and Accuracy Present Tasks Calling for Wide Range of Techniques; Thus a New Specialist Is Developing

By George E. Donnelly

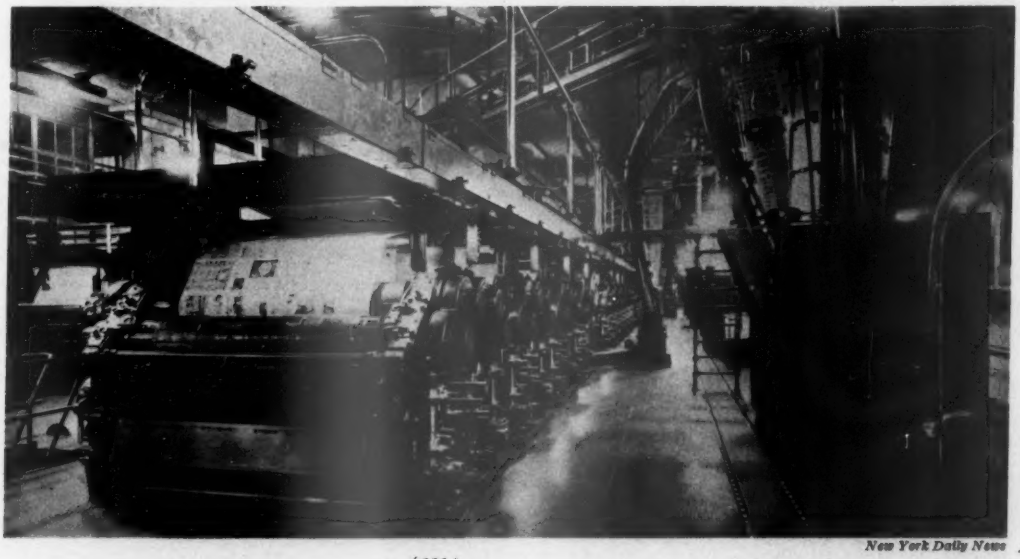
MOTION pictures and short stories have so glamourized the newspapers that scenes of reporters, city desks, and teletypewriters are familiar to everyone. But both the magic of the screen and the license of fiction have passed over the actual mechanical production of the newspaper. The movies show the hero rushing into the editorial room, punching out a story, hurrying it to the editor — then the scene fades. Next, the newsboy on the corner is shouting "Extra," and the front-page headlines are featuring the story.

Unrecorded, there has occurred between these two scenes one of the most fascinating and challenging manufacturing production tasks in modern industry, performed in more than a thousand newspaper printing plants all over the country every day.

With Gutenberg's invention of printing from movable type five hundred years ago, the first step toward the rapid duplication of original manuscripts had been made. Inventions which followed have made possible an ever increasing speed of printing. In the 1700's, the development of stereotyping permitted the simultaneous use of printing plates cast in plaster-of-Paris molds made from a single original assembly of type. The introduction of the half-tone engraving process in the latter part of the Nineteenth Century made possible the use of pictures in newspaper printing. About 1850, the cylinder press was invented, and when curved stereotype plates were adapted to the rotary press, the beginnings of present high-speed printing had taken form. One other step which contributed to the rapid preparation of material for printing was the invention of the mechanical typesetting machine around 1880.

The art of high-speed printing has reached its most advanced state in the modern newspaper plant. Competition of radio and magazines has not reduced the demand of the public for the daily newspaper. Twenty years ago the total circulation of daily papers was about 28,000,000 copies. Today, in the United States, 40,000,000 copies of English-language newspapers are printed daily. One metropolitan paper has a circulation of 2,000,000 daily, another more than 1,000,000, and several others between 500,000 and 1,000,000. Sunday-morning circulations of 1,000,000 are not uncommon, and one city paper prints 3,800,000 copies. If the sheets of all copies of that Sunday paper were laid end to end, they would form a continuous band about 40,000 miles long.

The selection, maintenance, scheduling, and operation of equipment to produce these papers constitute a challenge to the best of management. The paper *must* be printed. Temporary delays and failures are costly to all industries, but they are almost fatal in newspaper printing. Minutes count, for the man who wants to buy a newspaper will not wait, and a competing paper is always on the newsstand. Time cannot be made up in



A modern newspaper press-room. Papers are automatically counted and delivered on continuous conveyers to a shipping room. The track on the floor (lower right) is a plate conveyer which carries the stereotype plates from the stereotype room to the presses.

New York Daily News

New York Daily News

Into the page compositors insert lines of type produced in type-casting machines. Photoengravings of pictures are also put into the page at this time. No printing is done directly from type.

newspaper production — an extra shift cannot always be used to print the copies lost in an earlier production failure — because today's news and today's paper are worthless tomorrow.

Though speed is of fundamental importance, it is by no means the only problem. Quality and accuracy are essential. No advertiser, for instance, will pay for a poorly reproduced advertisement. Modern advertising is both a science and an art; specialists employed by the advertiser or his agency spend days preparing copy which is to have a particular effect or appeal. If the desired effect is not secured in the printed result, the printing is not successful. For success, then, pictures must be carefully reproduced, ink must be properly adjusted, and yet speed of production must be attained. Needless to say, nothing in the mechanical preparation of the paper should condone inaccuracies. Errors in advertising or editorial material must not occur, and speed of operations is never an excuse for their occurrence.

The daily printing of 2,000,000 copies by one large newspaper requires a first-class production organization and the very latest and finest mechanical equipment. The plant of this huge metropolitan paper is equipped with an hourly press capacity of more than 700,000 complete, folded papers; news rushed from the editorial room is rolling off the presses in less than twenty minutes.

To the layman, modern newspaper printing presses are miracles of engineering. To watch the continuous webs of paper whip through the printing rollers at 1,600 feet a minute; to see a sheet assembled with others in the proper order; to see it cut, folded, and delivered to the mail rooms without the motion of a single man, except for supervision, is thrilling not only to the layman but to the most experienced engineer as well.

The present method of printing consists of four fundamental operations: Copy is received from the editorial and advertising departments and is reproduced in type by the line-casting machines. Some of the very large elements, such as front-page headlines, are hand set from separate pieces of type. The type is then assembled in the proper page and position by compositors working under the eyes of make-up editors.

Pictures to appear in the paper are sent to the photoengraving department while the type material is at the type-setting machines. The engraving department produces photomechanical halftone engravings. When an engraving is complete, it is sent to the composing room, where it is assembled in its proper position with the type. It is then mounted on a base to bring it to the proper height in relation to the type. The complete page is locked securely in a frame, and the entire form is sent to the stereotype department.

Here, a moist matrix of the page is made, and curved stereotype plates are cast from the dried matrix. The plates are mechanically trimmed and shaved to insure proper thickness and perfect fit to the cylinders of the printing press.

Carried by the rotating cylinders, the plates receive ink from a roller and then transfer the ink to the paper web. The paper is fed continuously to the press from large rolls, weighing almost a ton, mounted on reels beneath the press. A folding unit assembles and folds the paper, counts and delivers the completed newspapers to conveyers which, in turn, carry them to the shipping rooms.

The process appears routine and exact. When viewed by the man not in the profession, it may seem amazing and very nearly perfect. But is it?

The least complicated step in the entire system of newspaper production is the preparation of the stereotype plate. Brief analysis of some of the unknown factors in this simple procedure may indicate how little is actually known today about the mechanical processes used in printing. First, the papier-mâché flong, or unmolded matrix, may be studied. It is composed of cellulose and may be said to resemble a desk blotter. Manufacture of the flong is difficult and exacting, for the material must be free from large fibers or other imperfections which might appear on the face of the matrix and hence on the printing surface of the plate cast from the matrix. The moisture content of the flong is of

fundamental importance and should be carefully controlled in the manufacture. At times, complete shipments must be returned to the producer because they are unsatisfactory. The moisture content must be sufficiently high to permit effective molding without fracture. Excessive moisture makes the flong mushy, and a longer period of drying would be required before the casting operation.

More often, difficulty with the flong is a result of the atmospheric conditions under which it is stored. However well the moisture may have been controlled in the manufacture, unless that same condition is maintained until the time of use, unsatisfactory molding may result. The correct atmospheric conditions have not yet been established and are not in common use by the newspaper plants throughout the country.

In the stereotyping process the assembled page of type and pictures is brushed free of dirt or other pieces of extraneous material, and the moist flexible flong is placed on top of the page. A cork impression blanket one-quarter of an inch thick is placed over the flong, and a thin steel plate is put on top of the cork. The platform on which they are positioned is moved beneath a large roller, clearance under which is less than the overall height of the type, flong, cork molder, and steel plate. Thus, as they are passed beneath the roller, the cork is compressed and exerts pressure on the flong, which molds itself to the shape of the type and pictures. Uniformity of thickness of the matrix thus produced is necessary, for any variation in this dimension will later be reflected in unevenness in surface of the plate to be cast.

The physical characteristics of the cork molder are obviously of great importance. A stiff hard cork will result in excessive pressure on the matrix and will lack the flexibility essential to the proper depth of the molding. A highly compressible cork will cause inadequate pressure and unsatisfactory molding. No two cork molders, as received today, are alike. Each time a cork is changed, an adjustment must be made in the setting of the molding roller. The adjustment is done by the stereotyper, who gauges it by inspection of the molded matrices. No method has yet been devised to test the cork and obtain a setting for the roller. It is now entirely a matter of judgment of the practical man, and the results are not always satisfactory.

Other variables further complicate the molding operation. Repeated use of a cork results in fatigue, so that an original setting must be frequently revised. Of even greater effect is the variation in the make-up of different pages. Obviously, a page composed entirely of the almost flat areas of pictures requires a greater pressure for proper depth of impression in the matrix than does a page made up solely of individual type characters and figures. The adjustment of the roller for the required pressure is important, but under the present operation the sole determining factor is the judgment of the stereotyper. If the resulting matrix appears unsatisfactory, another one may be made with a revised pressure setting, but speed requirements do not always allow this repeated molding.

The matrix is moist and flexible after molding. It must be reinforced and dried to withstand the pressure of molten stereotype metal. As the matrix conforms to the composition of the page which it is to reproduce, the cork molder forces the flong down into those areas between the type which are not to print. Thus, the back of the matrix — the side away from the surface bearing the detail — is not smooth. It is important that those areas depressed from the rear should not be forced back into level position by the pressure of molten stereotype metal during molding. Insurance against such deformation is accomplished by a slow and tedious process — a hand operation called "backing" — which involves the pasting of strips of adhesive cellulose into all the hollow areas on the back of the matrix. This operation is a bottleneck at present. Several men working simultaneously on a single matrix are required to speed the production. Placing the packing in the proper areas demands skilled and experienced stereotypers. No area which might fail under pressure must be missed, and any area which has sufficient strength to obviate the necessity for packing should not be packed. Time is too valuable to be wasted further. (*Continued on page 126*)

Molding the matrix to be used in casting the curved plates from which the newspaper is printed. Note the original type, papier-mâché matrix, flexible cork, and curved pressure roller.

New York Daily News

What's Happened to Television?

Troubles in Video Engineering and How They Are Busying the Remarkable "Committee of 168"

By Donald G. Fink

THE classic story about committees relates to Mrs. Charles F. Kettering, who, seeing Lindbergh's plane at the Smithsonian Institution, turned to Mr. Kettering and said, "To think that he did it all alone!" To which remark her experienced husband replied, "It would be a great deal more remarkable, my dear, if he had done it with a committee." Committees are so notoriously cumbersome when called upon to settle controversial issues that the "Lone-Eagle" approach has an almost irresistible appeal. A committee, like a democracy, usually arrives at the best compromise, given time. But when time is an element, the results may be nil.

The story of the National Television System Committee is therefore one of the most remarkable in the recent history of technological standardization. This committee, instituted late in July and organized the following month, is composed of no fewer than 168 members and alternates who in less than four months devoted 3,000 man-hours to committee meetings alone and spent an additional 3,000 man-hours in travel and preparation of reports. The proceedings of the meetings — minutes and supporting documents — run well over a thousand pages. A quarter of a million sheets of paper have been consumed in circulating this material to the members of the committee, at a cost of over $6,000. This accomplishment has been brought to pass by several circumstances: Every man on the committee has a vital interest in the outcome of the deliberations, and so has the company for which he works; the committee was working against a dead line "suggested" by the Federal Communications Commission; and the organization of the committee was very skillfully contrived to avoid wasted time and effort. The result is that all the standards for commercial television broadcasting, excepting a few minor points, have been examined and re-examined; final recommendations, made by a record vote, are ready for presentation to the F.C.C., complete with minority reports. The government agency will hear a progress report from the committee on January 27. Thereafter, barring unforeseen contingencies, the F.C.C. will promulgate the recommended standards as official for the United States, and television will be off again in full stride.

If this hoped-for event takes place before next Easter, television's stride will have faltered for less than a year. For it was on Easter morning, 1940, that the radio industry woke to find on the front pages of the newspapers the startling announcement that the Federal Communications Commission had decided to withdraw its promise of early commercialization of television broadcasting. The reason given by the F.C.C. was that commercial activity in marketing television receivers was in effect establishing a set of television-transmission standards to which the government had not given assent. The standards in question had been formulated over a three-year period, from 1936 to 1939, by a committee of the Radio Manufacturers Association, had been universally adopted by television-receiver manufacturers, and had been proposed for official adoption by the Federal Communications Commission. This step the F.C.C. had declined to take, stating that it neither endorsed nor rejected the proposals since in its opinion the art was in such a rapid state of flux that standardization was premature. The commission nevertheless went ahead with plans to permit television stations to broadcast on a commercial basis, the standards meantime being held in abeyance.

Setup for a television shot in miniature

N.B.C. Studios

This procedure was a mistake, as James L. Fly, chairman of the Federal Communications Commission, admitted later before a Senate investigating committee. With no official standards, the industry was preparing to launch commercial television, free to choose whatever standards it desired. The industry was

in agreement on most of the standards advocated by the Radio Manufacturers Association; hence they were the logical choice. But when activity proceeded along this line, the government realized that the R.M.A. standards were in effect being made official simply by putting into the hands of the public receivers designed for these standards.

Action followed swiftly on this realization. The public was warned against buying receivers, and the industry was publicly chastised for usurpation of a government function. Chairman Fly went on the air on a national network to justify the commission's action. Antiadministration newspapers cried "punitive action," "unwarranted paternalism." The hullabaloo reached such proportions that the Senate summoned Chairman Fly before a committee to explain the commission's action, and even President Roosevelt felt called upon to state to the press that he was sure the matter could be satisfactorily adjusted in a short time.

Seldom is the public treated to such a clear view of the problem of technical standardization, but it is doubtful that the lay reader realized what was behind the stories. Rather, he became confused, sure only that he would put off buying a television receiver until the government and the industry had composed their differences. Sales of television receivers fell almost to the vanishing point. Radio's infant prodigy, barely able to walk, suddenly found itself crippled and no crutch in sight. Budgets for television programs were pared. The owners of television receivers in New York, variously estimated at between 2,000 and 3,000 in number, found the quality and frequency of the programs declining. For two months, while a shift in wavelength was being made, no program service was available in New York at all, and a combined investment of nearly a million dollars in receivers languished. When service was resumed, the number of programs being transmitted had been reduced from fourteen or fifteen hours a week to four or five hours. Clearly something had happened to television.

Those familiar with technical standardization are well aware of the fundamental conflict between the necessity for standards in order to initiate an art and the inhibiting effect which standards have on the future progress of that art. Essentially that is the conflict which "happened" to television. In itself, however, that conflict was not solely to blame. There were also a generous admixture of ordinary misunderstanding of what items in television really require standardization, as well as a few philosophical footnotes introduced by the prevailing thinking of governmental regulatory bodies.

One of these philosophies is the principle enunciated by the Federal Communications Commission, that equipment or apparatus sold to the public should retain its "original degree of usefulness" indefinitely. Thus the crystal sets of twenty years ago are just as good today as ever they were; in fact, they perform better, because broadcast stations have improved in the meantime. According to the principle, the F.C.C. would not knowingly permit standard broadcast stations to change their method of transmission in any way which would lower the utility of the crystal set or any other kind of set sold to the public in good faith. (Parenthetically it should be noted that crystal sets and other standard receivers are not suitable for reception of frequency-modulated, staticless broadcasting scheduled for commercial operation this year, but presumably the standard broadcast stations will remain in operation to serve these receivers until the public has no further use for them.)

The application of the obsolescence-not-permitted principle to television sets is dictated by the fact that a variety of changes in methods of television transmission is conceivable. If adopted, these changes would render existing receivers completely useless. Note that these changes are *conceivable*. Whether they might become *desirable* changes is a moot question. This is one of the questions which the National Television System Committee has been called upon to answer.

The method of sending television pictures, it will be recalled, involves the analysis of the image in the television camera into a series of horizontal lines and the transmission of the information contained in these lines, one after the other, until the whole picture has been covered. The process is repeated rapidly enough so that many pictures may be sent each second. The number of lines required depends on the degree of pictorial detail desired vertically in the reproduction, whereas the number of pictures to be sent each second is determined by the tendency of the pictures to flicker and by the necessity for reproducing motion smoothly. When these specifications have been decided, the detail along each horizontal line is governed by the space in the ether assigned the transmission system. (*Continued on page 129*)

"Patience," the dummy, poses for her teleportrait while an engineer makes measurements of the light reflected from her countenance.

N.B.C. Studios

Man's Relation to the Cosmos

One Must Pay for What One Gets, in Cosmic Dealings as Well as in Other Affairs

By Cecilia Payne-Gaposchkin

THE title of this essay presents a great temptation to an astronomer. To interpret it in a technical sense and to write a discourse on "Recent Advances in Astronomy" would be easy. But astronomer though I am, that is not what I propose to do. The subject that I have chosen is the housing problem: where to live? how to find the means? how to use them to make life possible? how to make life not merely possible but also pleasant? The purpose of this essay is to describe the advantages of living in the cosmos.

There are two parties to every transaction — even to this of living in the cosmos: You, and the cosmos. And two questions to be answered: What has the cosmos to offer me? What have I to offer the cosmos? Do not let the second question surprise you. Engineers, physicists, and chemists are in daily practical contact with one of the fundamental laws of nature. In the dry, legal terminology of science we call it the conservation of energy. When translated into the language of everyday life, it runs: "One has to pay for what one gets." Few of us expect to get something for nothing in a commercial transaction; those few who manage to, do so by imposing on their fellow men. But who ever thought of trying to impose on the cosmos? There are no exceptions to the operations of gravity and centrifugal force. As surely as we have to pay in human currency for the material things we acquire, we must pay in universal currency for the benefits we receive from the cosmos. And the best things come high — so high, indeed, that we cannot afford some of them at present.

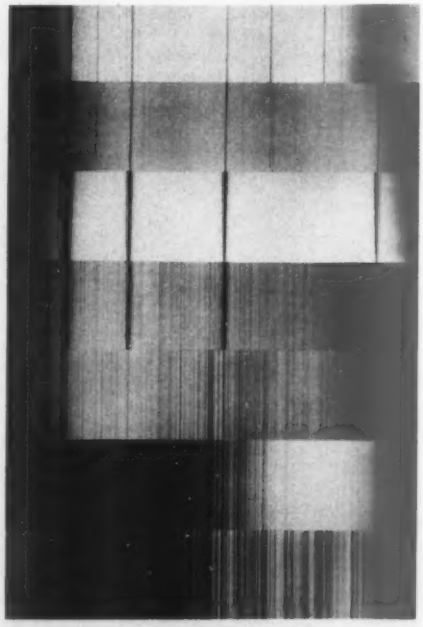
But I am getting ahead of myself. We must examine what the cosmos has to offer to man. First come the raw materials, the atoms — I had almost called them the fundamental units of the cosmos, but we all know better than that nowadays. The generation that called atoms "the unsplittables" knew more Greek than physics. This sort of thing is used today as an argument against classical education but should rather be used as a warning to the science of any day, lest it think that its latest findings are the ultimate truths. Even though the atom has been dissected and redissected, let us take it at its face value. It is lucky for you that I am not a metaphysician. If I were, I should spend the rest of this essay in the attitude of the centipede, who, when she was asked:

> . . . which leg came after which
> . . . . . .
> She lay distracted in a ditch
> Considering how to run.

What does the cosmos offer to us in the way of atoms, of chemical elements for building our homes — and for building ourselves, for that matter? A quantitative analysis of the universe is difficult to make. We can perform spectral analyses only of matter that is radiating or absorbing light in the form of line or band spectra. We really do not know how much "dark" material is in the stellar system, and we know still less about what it is made of. The stars, which are radiating at high temperatures, are easier to analyze. We can make our analyses only of their outer skins, however, thus taking a census of perhaps .000 000 000 01 of the total atomic population. Probably the lighter atoms have a tendency to drift to the upper layers, so that elements like hydrogen and helium are apt to be overrepresented in analyses of the stars.

The spectrum of the well-known naked-eye star, Capella, evidently consists of a number of dark lines crossing a brighter background. The lines look dark, but that appearance is only an effect of contrast. They are no more totally black than a sunspot is. A qualitative analysis of Capella's outer skin is comparatively easy to make. When the wavelengths of the absorption lines have been measured, identification of the atoms that are responsible is easy. In the spectrum of Capella are scarcely any lines that are not known in laboratory spectra. Certainly there are no strong ones. The atoms in the atmosphere of Capella are atoms that occur on the surface of the earth; nothing suggests the presence of other atoms in any great quantities.

The spectrum of the sun is very like the spectrum of Capella; in fact, at first glance you would probably say they are identical. But there are two important differences. First, Capella is twins, whereas the sun is single. Capella's



The stellar spectral sequence

duplicity cannot deceive the spectroscope; the lines give it away. Second, the sun is a dwarf, and Capella is a giant thirteen times as large as the sun, heavier, and brighter. You could tell that fact even from their spectra, although it is well established for Capella and the sun in other ways. Two spectral lines, the ultimate lines of neutral calcium and ionized strontium, can be used as a basis for a pretty shrewd guess at the size and brightness of a star, because they are very sensitive to the effect of gravity. When the gravity is low, the line 4215 of ionized strontium is relatively stronger than when the gravity is high. One sees at a glance that it is lower on Capella than on the sun.

In spite of their differences in size and multiplicity, the sun and Capella are found to be identical in chemical composition. A very careful study of the qualitative composition of the sun, carried out with spectra of enormous dispersion, leads to the conclusion that all terrestrially known substances that could possibly give spectral lines, within the region we can study and at the solar temperature, are present on the sun. Qualitatively, the sun and the earth are of identical chemical composition, a fact which is, perhaps, not very surprising if we are right in guessing that the planets were born of the sun.

Harvard College Observatory

The Southern Milky Way in Carina and Crux

The quantitative analysis is more tricky. Even if the skin effect is ignored, there remains the difficult problem of deducing the numbers of atoms of a given kind from the strength of their absorption lines. We can readily tell how many atoms are producing a particular line, say, a line in the spectrum of neutral iron. But to deduce from this fact how many atoms of iron are present altogether is a problem of a very different order. The spectrum of neutral iron contains thousands of lines; so do the spectra of once and twice ionized iron. The possibilities obviously are enormous. Moreover, it must not be forgotten that many spectral regions of the stars, notably the ultraviolet, are inaccessible to photography.

The distribution of the atoms among the possible states of ionization and excitation depends on the local temperature and pressure. How much effect these factors can have may be seen from the photograph on the opposite page. The spectra of almost all the stars can be arranged in a continuous sequence. And the upshot of observation and theory concerning the atmospheres of these stars is that they are all of the same composition. The differences that are so apparent to the eye are caused by differences of temperature and pressure, principally by the former.

How does this fact concern us? It tells us that the sun and most of the stars are of identical chemical composition. In other words, the cosmos provides us on the earth's surface with a perfectly representative sample of the universe. These are our raw materials. Of these we must build our houses, and ourselves.

Living matter seems to have stuck even more closely to the composition of the cosmos than to that of the earth itself. If you analyze yourself, you will find that you contain relatively more atoms of hydrogen, carbon, nitrogen, and oxygen than the earth does on the average. In building himself, the living creature has used the typical cosmic sample. He is the child of the stars, rather than of the earth. Luckily for us, we are situated near a pretty average star. Some parts of the universe appear to be relatively deficient in carbon. And our civilization is essentially a carbon-compound civilization. Our style would be severely cramped by a shortage of carbon atoms. For carbon we have never found, and shall probably never find, a satisfactory atomic substitute.

WHAT does the cosmos offer in the way of a site? There, indeed, we are lucky. Few building lots are so propitious. Our site, of course, conditions the kind of house we are able to build. We are a little prone to forget to what extent our surroundings dictate our structures.

Imagine yourself for a moment at the surface of Betelgeuse, the gigantic red star in the constellation of Orion. Some day I mean to write a textbook of astronomy and physics for use at the surfaces of supergiant red stars, where there are no solids, no liquids. One could form no macroscopic conception of structure. There would be no geometry, no ideas that depended on form or rigidity. That fact would make very difficult most of our mathematics and all of our classical physics. The so-called new physics would probably be classical physics on Betelgeuse.

But would not astronomy be the same there as here? Far from it. Probably nothing would be observed which could give a clue to the laws of motion and the idea of gravitation, unless, of course, Betelgeuse is blessed with planets. Even the idea of the geometry of the universe would be different from ours. Parallaxes would not be measured from opposite sides (*Continued on page 123*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Training for Defense

EMERGENCY courses for engineers and technicians urgently needed in the nation's defense industries will be started this month and in February under a co-operative program sponsored by the Institute, Harvard University, Northeastern University, and Tufts College. The proposed program comprises full-time day courses as well as evening courses of college grade for men who are employed. Organized to comply with the engineering defense training program of the United States Office of Education, the courses are part of a nation-wide project supported by the government for specialized training in fields essential to national defense. The courses will be offered if there is sufficient demand to satisfy the requirements of the United States Commissioner of Education and will be given without tuition charge to the students.

The other engineering schools in the northeastern regional district, which includes Maine, New Hampshire, and Vermont as well as Massachusetts, are preparing to offer similar intensive courses. These programs are being planned by the individual colleges, which have the co-operation of the regional adviser on engineering defense training, Edward L. Moreland, '07, Dean of Engineering at the Institute.

The joint program of the four Greater Boston institutions was arranged to avoid duplication of courses and to assure the most effective utilization of the special teaching and laboratory resources of each. The committee in charge of the project, which is expected to train approximately one thousand students, includes Harald M. Westergaard, dean of the Harvard Graduate School of Engineering; Raymond D. Douglass, '31, Professor of Mathematics at M.I.T.; William C. White, dean of the College of Engineering of Northeastern University; and Harry P. Burden, dean of the Tufts Engineering School.

None of the courses conflicts with or replaces regular evening courses now being offered by such agencies as the Massachusetts University Extension Division, the Lincoln Institute of Northeastern University, the Lowell Institute School, or the university extension courses of Tufts College. In general the requirements for admission include at least three years in an accredited engineering school or its equivalent. In some instances two years in an evening engineering school plus practical experience may be considered sufficient preparation, and in certain cases other preparation may be acceptable. Some highly specialized courses will require engineering degrees. Application for detailed information on all courses to be given at the participating colleges in the Boston area should be made immediately by mail to the Engineering Defense Training Bureau, Room 7–102, M.I.T., Cambridge.

The subjects of the full-time day courses, which will be the substantial equivalent of one full college term of sixteen weeks, are expected to include airplane power

M.I.T. Photo

Memorabilia of Emma Savage Rogers, wife of Technology's first President, on exhibition in the room that bears her name. The silver tray, presented to her by the students of 1865–1885, was given to the Institute by her nieces after her death, for use by the wives of Presidents of the Institute.

M.I.T. Photo

Engines on display in the exhibition area which is a feature of the recently completed addition to the Sloan Automotive Laboratory . . .

plants, airplane structures, camp sanitation and water supply, building construction, defense production and co-ordination, naval architecture, marine engineering, meteorology, mapping, topography and surveying, and aerial mapping.

There will also be for nonengineering students a full-time day course on engineering fundamentals. This course offers an opportunity to graduates of arts and science colleges who have fundamental training in science and mathematics to prepare themselves in the general field of engineering for employment in the engineering or production department of industrial concerns engaged in work related to national defense.

The proposed subjects of the evening courses, which will require from two to three hours on two to three days a week for periods ranging from twelve to twenty weeks, include machine design, production engineering and supervision, elementary airplane structures, radio communications, concrete construction and inspection, foremen training, chemistry in national defense, testing and inspection of materials, physical metallurgy, reinforced concrete, and welding engineering. Other evening courses will cover applied mathematics; applications of metallography; exterior ballistics, which is the mathematical treatment of projectiles in flight and requires advanced mathematical preparation; servomechanisms, the study of machines which anticipate and control other machines; vibrations and their applications; and instrumentation, which covers the use of engineering instruments employed in design and manufacture.

If there is sufficient demand, courses in other subjects may be added to the present program, and specialized courses may be established for groups in important industrial centers.

Popular Science Lectures

THE first of the annual series of four popular science lectures sponsored by the Society of Arts at the Institute was given on December 15, when Hoyt C. Hottel, '24, Associate Professor of Fuel Engineering in the Department of Chemical Engineering, discussed "The Sun as a Competitor of Fuels." Professor Hottel is chairman of the Institute's committee studying various uses of solar heat, including winter house heating, summer air conditioning, and power generation.

The second lecture of the series, "Color Photography," will be given by Arthur C. Hardy, '18, Professor of Optics and Photography in the Department of Physics, on Sunday afternoon, January 12. In his lecture Dr. Hardy will demonstrate the development of three-color photography and review the present status of color reproduction.

On February 16 George E. Russell, '00, Professor of Hydraulics in the Department of Civil and Sanitary Engineering, will discuss "Water and Water-Power Development," in a lecture which is to be supplemented by striking hydraulic experiments.

The final lecture of the series, "The Art of Soft-Ground Etching," will be delivered on March 16 by the distinguished etcher, Samuel V. Chamberlain, '18, who is a lecturer on expressions of graphic art in the Institute's School of Architecture.

Dental Clinic

A GRANT of $10,000 by the Charles Hayden Foundation to establish a dental clinic in the Richard Homberg Memorial Infirmary for the benefit of students of the Institute has been announced by President Compton.

The grant, which was conveyed to the Institute by J. Willard Hayden, President of the foundation created by his brother, the late Charles Hayden, '90, will bring to realization a plan long contemplated as part of the Institute's medical service to students. Through the generosity of the Hayden Foundation, Technology some time ago was presented with a 200,000-volt x-ray machine and fluoroscope equipment for general clinical examinations. Space for a dental clinic was provided when the infirmary was built in 1928, and plans are now going forward for installation of the necessary equipment.

The dental clinic for students is a service to reduce the development of physical impairments arising from faulty dental conditions. The clinic will provide for thorough examination and diagnosis as well as emergency treatment, and for advice to students for correction of defects by their own dentists. When the new clinic is established it is expected that dental inspection will become part of the regular annual physical examination required for all students at the Institute.

The addition of a dental clinic will give the Institute one of the most complete medical services for students in any educational institution in the country. The Department of Hygiene is administered by Dr. George W. Morse, medical director, and the staff includes four physicians, who conduct daily clinics, and a group of graduate nurses. Students receive medical or surgical treatment in this clinic without charge. In addition to being responsible for the health of the Institute's three thousand students, the Department of Hygiene provides similar service for the Institute's teaching staff of approximately five hundred and for nearly four hundred employees.

M.I.T. in the Last of the 1870's

BY EDWARD R. WARREN

IN a sense what follows may be considered an account of the Class of '81, my own Class. That is not actually the case, however; this is an account of the instruction and such matters as I recall them. Very little biographical matter is included here.

I entered the Institute in the fall of 1877 after my graduation from the Waltham High School. One other Waltham boy, Thomas Howard Barnes, entered at the same time but did not continue beyond the first year. Our Class was perhaps the largest that had entered for some years. It was large enough to occupy nearly, if not all, the desks in the first-year drawing room, our headquarters for that year. The first-year students were not divided into the different Courses they intended to take; that came the second year. Therefore, we all took the same studies and had the same instructors. For some of the studies the Class was divided into two sections, A through L and M through Z. School hours were from 9:00 A.M. to 1:00 P.M. and from 1:30 P.M. to 4:30 P.M.

Some of the members of the Class came from various towns near Boston, living at home and commuting every day. I think hardly a railroad entered the city but brought one or more students. Three of our Class — Duff, Lund, and Norris — walked from Charlestown all through the four years. There were also students from various parts of the country who lived in boarding-houses during the school year. Most of the commuters brought their own lunches. In a sort of second story at one end of the gymnasium was a restaurant, then run by a colored man named Jones.

M.I.T. Photo

Winners of the Charles Hayden Memorial Scholarships assembled in the office of President Compton for presentation of certificates of award by J. Willard Hayden, President of the Hayden Foundation. Seated left to right are Mr. Hayden, Dr. Compton, and Dean H. E. Lobdell, '17, chairman of the committee on undergraduate scholarships. This year's group of Hayden scholarship men includes thirty Greater Boston students and five from New York. The Hayden Memorial Scholarships were established two years ago by the Hayden Foundation as a memorial to Charles Hayden, '90, to assist in the education at the Institute of young men who, by their previous records, show future promise in the fields of engineering and science.

. . . This efficient machine shop is part of the new Sloan Laboratories, providing ample working space that frees the adjacent test floor for appropriate uses.

M.I.T. Photo

In the drawing room, where we lived when not in classes, Henry N. Mudge, '74, was the head instructor, and Henry K. Burrison, '75, his assistant. The former left in June of 1881, but Burrison remained for many years and was much liked. I know we all thought a great deal of him. Professor William Ripley Nichols, '69 (Billy Rip, as he was usually called behind his back), lectured us on general chemistry and qualitative analysis and was in charge of the first-year laboratories, where we worked two afternoons a week. Nichols had a rather sharp tongue, and I think we were a little shy about arousing it. A stupid answer to some question in class would sometimes bring a sarcastic comment.

Professor William P. Atkinson lectured on various subjects — rhetoric, English, political economy, and I have forgotten what else. His talks were interesting but were apt to be rather disconnected. He always gave an examination at the end of the term but never gave any marks; just passed the whole class. We doubted if he ever read the papers. We had three hours a week in French. Jules Luquiens was the instructor — a Frenchman and a very pleasant person. I think we all liked him. Webster Wells, '73, had us for three hours a week in mathematics — possibly algebra, but anyway geometry and trigonometry, I am sure. He was competent and taught for many years.

We had a course of lectures on logic from Professor George H. Howison. I recall nothing about them and am inclined to think that as soon as I had written the last words to my final examination paper I dismissed the subject from my mind. I do not think the course continued after that year. Dr. Samuel Kneeland was the secretary of the Institute and gave us lectures on physiology. We had military drill three hours a week. Lieutenant Henry W. R. Hubbell, Jr., of the artillery was our professor. We had blue uniforms: blouses and trousers and caps with flat visors. Twice during the school year we made a trip down the harbor to Fort Warren, marching through the streets to the wharf.

With the beginning of the second year the Class split up into the various Courses selected by its members. The civil and mechanical engineers and architects had drawing rooms on the third floor under the professors in charge of those Courses. John B. Henck headed the civils, Channing Whitaker, '69, the mechanicals, and William R. Ware, '75, the architects. The miners and chemists were downstairs in the basement, with headquarters in the laboratories. I had selected the natural history course and also hung out in the chemical laboratories. Nichols had qualitative analysis the first term, but gradually the boys were moved into the quantitative laboratory under Professor Charles H. Wing, until I was left alone in my glory. I would also have gone, but Professor Wing had no room for me just then, and I had to stay where I was until the second term. Professor Robert H. Richards, '68, was in charge of the miners for many years and was very popular.

Professor Charles R. Cross, '70, lectured on physics the second year and was a very fine lecturer. He knew his subject thoroughly and explained things in terms easily understood. The lecture hour was from twelve to one, and at the end of the lecture he would ask, "Are there any questions? If not, that is sufficient," and away we would go. Occasionally he would keep right on to one o'clock, and then it was, "Arethereanyquestionsifnotthatissufficient," all in one breath. There were never any questions then.

I think Professor William H. Niles lectured to us on physical geography the second term of that year, but I am not sure. The third year he and William O. Crosby,

'76, Assistant Professor, gave us geology, and I was rather under their charge during the fourth year. Professor Charles P. Otis taught us German the second and third years. Although I used German some in my studies the fourth year, I was anything but proficient in the language. The second half of that third year we had zoology under Professor Alpheus Hyatt, curator of the Boston Society of Natural History. He was a fine man with whom I had much to do during the rest of my time at the Institute.

Professor John M. Ordway taught various subjects, mostly relating to chemistry. There was a saying at the Institute that when a teacher was needed for some subject and no one else was available, the job was wished on Ordway. He was certainly a widely informed man. It seemed to me that there was nothing you could ask him to which he could not give you an answer.

The instructors remained the same during the rest of our years, though of course their subjects changed as time went on. I can say nothing about the work of the three groups upstairs. The chemists and miners lived in the chemical laboratory, and I with them; so of course I knew them best. The third year we had physical laboratory, and there Professor Cross had a fine assistant, Silas W. Holman, '76. There were two men in charge of the Department of Mathematics — Professor George A. Osborne was the head and Professor Gaetano Lanza was his assistant. The latter remained at M.I.T. for many years.

The fourth year all the candidates for degrees worked at their theses. Our Class was the last to be graduated under the presidency of William B. Rogers. He had already resigned, and Francis A. Walker was to succeed him. The next year, 1882, Rogers fell dead on the platform as he was addressing the graduating class: a fitting end for such a wonderful man.

The principal building at the Institute in my time was, of course, the Rogers Building, though it did not receive that name until many years afterward. Near the Clarendon Street side was a one-story building, the women's laboratory, where the women students in chemistry worked. Besides the laboratory, there were two rooms, part library and part laboratory, under Ordway's jurisdiction. Another one-story building housed the School of Mechanic Arts. Over nearer Clarendon Street was the gymnasium, where we had our military drill.

Now of the Class of '81 only five of those who took degrees survive: Came, Collins, Mower, Norris, and Warren.

Washington Times-Herald

At a banner meeting of the Washington Society of the M.I.T., Technology notables forgathered. President Compton of the Institute and President Bush, '16, of the Carnegie Institution of Washington are here shown flanking Merton L. Emerson, '04, President of the Washington Society.

Councillors and Colloids

RECENT developments in chemical engineering, with particular emphasis on the colloids, were discussed by Ernst A. Hauser, Associate Professor of Chemical Engineering in charge of the colloid division of the Department, at the 216th meeting of the Alumni Council, held on the last Monday in November. Dr. Hauser illustrated his interesting address by conducting experiments and showing moving pictures.

Before Dr. Hauser was introduced as speaker of the evening by President Henry E. Worcester, '97, various matters of business were transacted. Announcement was made by H. B. Richmond, '14, of the hanging of a portrait of the late Everett Morss, '85, in Everett Morss Hall of Walker Memorial. Richard Whiting, '26, chairman of the Alumni Day committee, reported on progress to date in the making of arrangements for next June's festivities.

Sailing Trophies

THE Intercollegiate Yacht Racing Association recently announced two new racing trophies of special interest to Technology. One of these is the Erwin H. Schell ('12) Trophy, presented to the association in recognition of Professor Schell's notable work as one of the founders of sailing at the Institute as a recreation for students. The trophy was presented to F. Gardner Cox, President of the Intercollegiate Yacht Racing Association, by President Compton, who spoke of the fine influence of yachting as a college sport and recreation. Next fall the Schell Trophy will replace the Boston Dinghy Club Cup as the prize offered for the major regatta of that season.

The second new trophy is named for Walter C. Wood, '17, master of the Senior House and master of sailing activities at Technology. Jack Wood has, perhaps, done more than any other single individual to establish firmly intercollegiate sailing, and the increase of college sailing clubs throughout the country has been influenced by development of the sport at Technology. The trophy was presented to the association by the intercollegiate yacht clubs of Brown and Harvard universities and Dartmouth College, as well as by a group of interested individuals. It takes its place as a trophy for the annual quadrangular regatta which is held between those colleges and M.I.T.

DEFENSE AND TECHNOLOGY

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may be stimulated to devise new tactics by which those nstruments can be used to best advantage. Tardiness in doing so has been the traditional weakness of the military commander. The overcoming of this disability probably more than any other one fact accounted for the brilliant German victories in the fall of 1939 and the spring of 1940. If the engineer's military training is intended primarily to stimulate his inventive faculties, there will have to be a minimum of squads-east and squads-west and of maneuvering of horses — whether in polo or in artillery limbers — and a maximum of real training in modern methods of battle.

None of the foregoing should be construed as a declaration for the conversion of our colleges and universities into academies of war or as a desire to Spartanize our society. There is no point in preparing to fight at all if we are not striving to defend what we deem to be the indisputably good ends of life, of which the pursuit of knowledge for its own sake is one of the foremost. The unraveling of the mysteries of the outer universe as well as of objects on this planet is, like great art, an expression of the finest aspirations of man. That such pursuits be displaced is decidedly not advocated. But it is urged that studies specialized to the arts of war be placed *alongside* those specialized to the mechanical arts of peace. This is no time to contract education. It must instead be expanded to include those arts by which our society may be defended from evil.

Finally, a word may be spared on the role which the technological institution shares with any other institution of learning in the teaching of our youth. Whatever may be said or wished regarding the inculcation of intellectual dispassionateness in our students, the fact remains that men cannot fight successfully if they are stimulated only by an analysis in cold reason that their cause is the better one. It would be tragic to depend on a silent reservoir of faith, only to find at the critical moment that our colleges themselves had been instrumental in destroying that faith. To win a war requires enthusiasm and determination. We shall therefore only at our extreme peril disdain to influence conviction. But what is the role of persuasion in a university and in a democratic society? If by the exercise of reason we conclude that certain things which are challenged are worth fighting for, we are compromising neither with truth nor with the ends for which a university exists by indicating that these ideals can be and ought be presented in such light as to provoke the resolve to fight for them. In the event of war, there must be faith in the cause, a spiritual dynamism, not that mild cognizance which is next to apathy. To know what is better does not suffice; we must also want what is better with all our souls, or we shall not have it.

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[8] *Ibid.*, p. 189, note No. 9.

[9] A small portion of this literature is cited in the bibliography prepared under the direction of Pendleton Herring: *Civil-Military Relations* (Chicago: Public Administration Service, 1940), pp. 50–64. The American literature on the subject comprises mostly works descriptive of our industrial effort during the last year; see *ibid.*, pp. 10–33; also *Problems and Policies in Industrial Relations in a War Economy*, ed. Industrial Relations Section, Princeton University (1940).

[10] Vagts, *op. cit.*, p. 1.

[11] André Maurois, *Tragedy in France* (New York: Harper, 1940), p. 49.

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MAN'S RELATION TO THE COSMOS

(*Continued from page 117*)

of an orbit in space, as we measure them. They would have to be measured at the beginning and end of a half rotation, a requirement which would give an even bigger base line than ours for the triangulation of the universe because Betelgeuse is larger than the earth's orbit round the sun. But unfortunately for the Betelgeusian measures of parallax, the star is subject to radial pulsations. Perhaps the hypothetical inhabitants might be able to detect these from changes in gravitation, but if one were ignorant of the laws of motion, gravitation would be hard to explain. For observers on the surface of Betelgeuse, the radial pulsations of the star would throw the determinations of parallax into such confusion that the local astronomers might even be compelled to postulate a pulsating universe. This digression is perhaps a little more than an idle fantasy: It is a healthy discipline for us to consider how far our findings are inevitably tinged by our circumstances.

Compared to the surface of a star, the surfaces of the planets are Elysian. Nevertheless, life exactly on our terms would not be possible on any of the solar planets. Life on the same lines, adapted to the local conditions, is possible on a couple of them. Jupiter, Saturn, Uranus, and Neptune can be ruled out as possible sites. They are too cold, and probably their dense atmospheres are thousands of miles deep. Mercury is impossible, too; it is devoid of atmosphere and water and subject to intense heat. The planets Venus and Mars might be suitable sites for life of some sort; when I say life, I am thinking of the particular type of animated carbon chemistry of which we, among other creatures, are by-products. Every one of the planets presumably provides all the raw materials necessary for these chemical reactions. Only a few of them present sites where the raw materials can be put to this particular use. And of the three planets that offer any foothold at all, the earth probably presents the best.

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MAN'S RELATION TO THE COSMOS

(*Continued from page 123*)

The earth seems like a very small fertile spot, a veritable oasis in the middle of the cosmic desert. Possibly, even probably, there are other such oases. Absolute exceptions are very rare; in fact, when we ourselves are the exception, a safe rule is to assume that we are indulging in self-deception and self-aggrandizement. Not the slightest chance exists, however, of our ever detecting another oasis. For practical purposes we are occupying the only possible building site that we know.

Let us not be utterly utilitarian. What does the cosmos offer in the way of a view? What do we see from the windows of the world? The view is magnificent. The windows of our house look out upon the stars. How fortunate we are! If we lived on the planet Venus, our sky would be permanently clouded. But from the earth we have fitful glimpses of a vista that should go far to console us for material difficulty and discomfort. I think that most of the glowing descriptions that have been written about the stars have failed. I like best the brief words in which Dante throws off the horrors of the Inferno:

> Whence we came forth and saw the stars again.

HERE is the bill of goods that the cosmos offers to us: The raw materials are the same atoms that build the stars. The site is the best, if not indeed the only one, that we know. And the view is a vista that is magnificent in its austerity. But in this universe, there can be no question of getting something for nothing. How are we to pay for our terrestrial home? What have we to bring to the cosmos? As I said at the outset, we can have what we can pay for. I doubt whether any of us has any conception of how much the cosmos offers to us if only we can pay, any conception even of the nature of the currency. Let me be specific.

First, we bring to the cosmos our *need* — the stark and uncompromising urge for self-preservation and self-perpetuation. It has become such second nature to us that we think of it only with an effort. I mean the continual assimilating, adapting, rule-of-thumb experimenting that our bodies have learned to do unconsciously. There is, of course, nothing simple about the details of the process. Much of it is completely baffling when we consciously try to dissect it. Personally I chose astronomy, after a brief glance at the problems of biology, because I felt that astronomy offered *some* chance of enabling one to arrive at some final conclusions, and biology none at all. Nevertheless, this need is the small change in our transactions with the cosmos, that minimum which we must spend for a bare subsistence.

A bigger coin is *human ingenuity*. Invention is proverbially the child of necessity. Human ingenuity is the coin in which we buy from the cosmos the means to make life not merely possible but pleasant. The greater the ingenuity, the greater the pleasure. If we use our ingenuity to increase human suffering, the more fools we. Most foolish of all is to blame the results on the ingenuity. Lay the blame on the desire to give pain. Don't blame the gun; blame the man who fired it. If guns had never been invented, he would have used a battle-ax or a rock.

Need we have brought to the cosmos; need, and its child, ingenuity. These are the price of dwellings and of food. But man does not live by bread alone. Our lives are not full when we have fed and housed our bodies. We have something further to contribute. Even the most primitive man can bring to the universe a *sense of wonder*.

From unadulterated observation we can piece together a picture of the external universe, a picture which is altogether amazing and which puts a heavy strain on the imagination. Consider the immensity of things — the stars that are counted in billions; the universes that are numbered in hundreds of thousands, each with a stellar population of billions; the distances from star to star, measured in units of parsecs, or 3.1×10^{13} kilometers; the size of our own stellar system, for which that immense unit, the parsec, does not suffice, but which has to be measured in kiloparsecs; or the size of the system of galaxies, which has to be measured not in kiloparsecs but in megaparsecs. Only the limitations of our equipment, I am sure, prevent our having measured the greater system of systems of systems in megistoparsecs — the ultimate conceivable unit.

Enough. I have spoken of only one of the simpler geometrical properties of the universe — a property that depends on principles so well established that we hardly take the precaution of calling them hypotheses any more.

What is the effect on you? On me the impression is stunning — literally stunning. After the first couple of sentences my sense of wonder was blunted, and I was simply reciting numbers. And yet an appeal to that sense, by way of the largeness of things, marks the high point of most expositions of the cosmos. How often has one sat in exasperation to hear an astronomer crush his hearers with numbers! It is almost as dull as being anesthetized with formulas. It is astonishing how few scientific men will speak of the beauty of the universe. They are too much preoccupied with its size.

Those who can offer a *sense of beauty* to the universe are paying in valuable coin, and the cosmos makes a rich return. I do not want to be misunderstood when I speak of the beauty of the universe. I do not mean the thrill of standing under the starlit sky; personally I find the sight more terrifying than beautiful. Those who see beauty in it probably find the beauty in association.

Nor am I thinking in the terms of the poet:

> I saw Eternity the other night
> Like a great ring of pure and endless light,
> All calm, as it was bright,
> And round beneath it, Time, in hours, days, years
> Driv'n by the spheres
> Like a vast shadow moved, in which the world
> And all her train were hurled.

That is the sense of wonder speaking in another language — language that does not anesthetize but intoxicates.

No. The spectrum of Canopus is an example of beauty. At least it is intensely beautiful to me. Ah, well, beauty is in the eye of the beholder. (*Concluded on page 126*)

. . . little voice commands vast system

Mary picks up her Bell telephone. Her voice travels over miles of wire on poles or under streets. It travels on to the intricate equipment at the central office, attended by alert, experienced people. The response is instant, and Mary's important message goes through!

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Western Electric *. . . is back of your Bell Telephone service*

MAN'S RELATION TO THE COSMOS

(*Concluded from page 124*)

It is not a very far cry from this to the surgeon who describes a "beautiful malignant growth." We have to define what we mean by beauty. The basis is probably the same as with all pleasures — the pleasure of good food, music, painting — and fundamentally I suppose that recognition plays a greater part in all of these than most of us are willing to admit.

The beauty that I see in the spectrum, and in the Grotrian diagrams that represent its analysis, is no more nor less than the thrill of recognition, the ability to satisfy the urge to classify. This sense of classification is the basis of science, still rather an elementary sense, but opening the doors of profound pleasure.

Now we are beginning to get our fingers on the higher denominations with which to buy from the cosmos. A greater step carries us from the joys of classification to the greater joy of interpretation. And that opens up the beauty of the universe fully, in so far as the mere scientist can see it. The whole stress is then shifted in our picture of the cosmos. Interpretation entails a weighing of one thing against another. Hitherto we have been the center of the universe. Now we perceive that our orbit is governed by other things, some of them outside our ken. We cannot take things at their face value any more.

I should have liked to devote this whole essay to expanding that one theme. But I soon realized that I know too little — all of us know too little — to illustrate worthily the truth of the quotation:

> Things that are seen are not made of things that do appear.

Things that are seen, and events that are observed, too, are not caused by things that do appear; any astronomer can tell you that. Many stars, perhaps most stars, are accompanied and disturbed by unseen companions. The galactic system itself turns about a center that is concealed from us irrevocably by the clouds in space. The cosmic rays — one of the major phenomena of the universe — we have no idea where or how they originate.

I get a good deal of pleasure out of elaborating the thought that modern science is concerned with the Unseen. I am not talking mysticism or advocating obscurantism. I am insisting that the current picture of the universe is anything but a cut-and-dried factual diagram. It has the rhythm and coherence of a symphony — the composition and color of a painting. In the symphony, matter furnishes only the strings and the stops of the instruments; in the picture, matter is only the background. The notes of the symphony are sounded by energy; radiation forms and colors the picture. We perceive the cosmos by way of the nonmaterial. We hear the music in snatches — dimly and imperfectly; we have glimpses of the picture from far away. This is the beauty, the intellectual beauty of the universe, of which I spoke. The man of science who has this conception of beauty understands the poet's description of the scientific mood:

> To see a world in a grain of sand,
> And a heaven in a wild flower,
> Hold infinity in the palm of your hand,
> And eternity in an hour.

Let me summarize. In our bargain with the cosmos we are offered raw materials, a site, and a stately view. We offer to the cosmos human need, human ingenuity, a sense of wonder, and a sense of beauty. But one has to pay for what one gets; and the best things are expensive. We have only scratched the surface of what the cosmos has to offer. Our life is circumscribed by the unknown. I suspect that some of the possible returns would stagger our imagination. But we must pay in still higher coin if we expect greater returns.

NEWSPAPER ENGINEERING

(*Continued from page 113*)

After the packing, or backing, the matrix must be freed of all moisture, heated in preparation for the high temperature of the molten stereotype metal, and curved to fit the semicircular casting box. Heated vacuum driers curve the matrix and remove most of the moisture. Final drying is accomplished in curved scorchers heated by electricity. The process of drying and scorching is far from perfect. The correct time, temperature, and vacuum have not been standardized, and uneven drying frequently results. Failure to dry thoroughly will occasion failure of the matrix when the molten stereotype metal expands the lingering moisture into vapor. Excessive drying makes the matrix brittle, and fracture may occur when the matrix is placed in the casting box.

During the drying process, shrinkage of the matrix occurs. This is greater in one direction than in the other because the cellulose fibers lie in one direction and the greater shrinkage occurs along their length. Allowance for shrinkage must be made in the original composition of the page but can be only approximate since the degree of shrinkage is determined by the moisture content. Sometimes the contraction is so great that the printed page is smaller than it should be, and advertisers who have purchased space in the paper must be compensated. At other times the shrinkage is inadequate, and the fixed dimensions of the cast plate cannot accommodate the entire impression of the matrix. Type or picture materials are then defective at the edge of the page.

The heat-conditioned matrix is placed in the curved casting box and is retained in position by clips which are supposed to hold the mat securely in position during repeated castings but do not always do so. Any movement of the matrix will displace the printing surface on the cast plate and thus lead to poor registration of the printed page. Because of variations in the thickness of the original flong or in the pressure applied in molding, the clips may not grasp the mat securely, and printing difficulties will ensue.

Another problem occurs in the cooling of the casting box. Rapid production of plates requires prompt cooling and solidification of the stereotype metal. Water cooling of both the cylinder which forms the core of the casting box and of the outer curved surface which supports the matrix should be effectively controlled. Variations in the rate of cooling affect the structure and surface of the stereotype plate. Variations do occur, and the plates

produced are often far from satisfactory. The temperature of the water in the jackets has not been studied sufficiently to enable the best casting conditions to be determined; until it is, printing will not be perfect.

The proper temperature of molten stereotype metal before being cast is a matter of controversy. The lead-tin-antimony melt is maintained at a different temperature in almost every newspaper plant. These temperatures range from 550 degrees to 700 degrees Fahrenheit; such variation affects rate of cooling and quality.

In the casting operation the molten metal is pumped through a heated passage to a discharge tip, from which the metal flows down into the space between the matrix and the cylindrical core. Air entrained in the falling metal usually rises to the top of the casting before solidification occurs. More than the required quantity of metal is pumped into the casting box so that the imperfections shall not be concentrated in the plate but may rise to the portion above the matrix, forming a "tail" that is rejected and remelted. Too frequently, however, the defects occur in the plate, defects which cannot be observed by inspection but which appear only when the plate is subjected to operating conditions on the press.

Mechanically, the casting machine is an example of ingenuity and splendid machine design; every minute, from a single matrix, it automatically casts and delivers four plates, trimmed to the proper dimension. The overall process, however, is subject to wide variations and uncertainty. A required number of satisfactory plates is obtained, but even the best page is distinctly inferior to the proof taken directly from an engraving.

The process which has been reviewed is the least complicated of all the steps in newspaper printing and the one with the fewest problems. The composing, engraving, and press operations are more difficult, far more involved, and much more uncertain. Clearly, here is opportunity for research, for control, for standardization.

Why hasn't the important business of printing, especially newspaper printing, already been placed on a more certain and scientific basis? Why haven't science and engineering been used to standardize and perfect the operation? The answers are long and involved; more pertinent is the fact that engineering to meet these problems is getting into action. The newspaper engineer is a pretty recent arrival, however, for although the printing industry is one of the oldest, but few engineering colleges have had long-established newspaper-engineering courses. Engineers have not grown up with the business, and it has not been easy to convince all the newspapers or all the practical men in the industry that newspaper engineers are needed. Here and there, however, a progressive management has recognized the value of men with engineering backgrounds, and many of the old-time practical men are lending their experience and advice to young engineers in a mutually beneficial attack on the problems of newspaper printing.

The daily service required of the engineer is much the same in the newspaper as in any manufacturing industry. The duties and methods are those met in practically any modern production organization; the principal difference is that the newspaper industry is just starting to use the scientific (*Continued on page 128*)

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NEWSPAPER ENGINEERING

(*Continued from page 127*)

method and has not had the benefit of internal engineering which so many other industries have had from their inception. The manufacturers of press equipment and other essential apparatus, of course, employ trained designing engineers. But in the newspaper itself, where problems constantly arise and where the value of engineers might be great both in daily operations and in the conversion of requirements into specifications for the equipment companies, men so trained have been very few.

Those newspapers which have employed engineers have found them worth while. The New York *Daily News* now has five on its staff, four of them from Technology. One of the earliest newspaper engineers was William Baumrucker, Jr., '29, who joined that paper as a laboratory assistant and who played an important part in the development of a newsprint testing laboratory. In this work, Mr. Baumrucker was later assisted by a graduate of the Chemical Engineering Course at the Institute, William G. Dodge, '31. The work of the laboratory then expanded to include not only the analysis and specification of ink as well as newsprint but also hundreds of other tasks in the routine operations. Today Mr. Baumrucker is vice-president of the new and widely discussed daily paper *PM*. Mr. Dodge became production manager of the Philadelphia *Public Ledger* and later a contact engineer between the largest manufacturer of newsprint and the newspapers.

Beyond his many daily duties and services, two principal problems face the newspaper engineer. Both are big jobs, ones that will require research and the trained engineer to find their solutions. First is the need for standardization of the present processes, which has been discussed earlier in this article. The best and the easiest way should be found to do the hit-or-miss operations that are being carried on today. It cannot be found overnight but will require hours of effort and experimentation. Some of the work can be carried on within the newspaper plant itself, particularly in the larger newspapers where laboratory facilities and personnel are available; some may have to be done in the better equipped laboratories of research organizations or educational institutions.

The second task, even more important and certainly more difficult, is research in the development of new and better ways of printing. Today's methods are fundamentally the same as those of fifty years ago. Improvements have been made — stereotype plates are produced more rapidly and presses run at higher speeds — but there have been no fundamental changes. The modern press is a huge, heavy piece of equipment. A complete press capable of printing a sixty-four-page standard-size paper weighs more than 700,000 pounds. Elaborate foundations and spring mountings are required. Buildings must be particularly designed to carry the loads of presses and their vibrations. The presses must be heavy in order to retain the stereotype plates in proper printing position at high speed. The plates weigh forty or more pounds, and when the press is operating at maximum speed, each plate exerts a centrifugal force of

nearly half a ton. Variation in plate weights made necessary by the difference in make-up of the pages adds the problem of dynamic imbalance. Place sixteen such plates on a single press unit, and it is not difficult to see why presses are so tremendous and why the designing talent of the press builder is taxed by difficult problems.

Why should plates be so heavy? Perhaps the answer is that since the very beginning of the stereotype process they have always been made of heavy type metal. Actually, the only requirement of a press is to place a thin film of ink in the proper position on a thin sheet of newsprint, and to do so as rapidly and economically as possible. The massive structure of the modern press makes one wonder whether that requirement is not being met in a rather roundabout way. Is this really the way to print? Should not the plate be lighter? Will the newly developed plastics provide an answer?

No one newspaper or its staff can alone do the work implied by these questions. The skill of engineering and science will be needed. The continued co-operation of the designers and manufacturers of present equipment will be essential, and the guidance of the experienced craftsman will be invaluable. Organized research sponsored and financed by the publishers may be the best way of attacking the greater problems. But in the solution of the smaller ones, newspaper engineers may convince the printing managements that engineering has a place in the graphic arts.

As this movement grows, trained men will be needed in the printing industry. Today, few students select their courses to fit them particularly for the problems of modern newspaper production. If men so trained were available, they would play an important part in the expanding business of newspaper engineering. At M.I.T. an elective course approaches the graphic arts from the arts standpoint and provides a good general background. The need for technical courses has not yet, however, been widely recognized in the large engineering institutions.

The opportunities are great, and the problems to be solved are manifold. A student who today can choose studies which will form an integrated course to qualify him for such work will find the problems awaiting him. That training should provide a great opportunity for the newspaper and printing industry, the publisher, the skilled craftsman, and the engineer.

WHAT'S HAPPENED TO TELEVISION?

(*Continued from page 115*)

According to the original standards of the Radio Manufacturers Association, a picture is divided into 441 lines (about 410 of which are active in the reproduced picture); pictures are sent at a rate of thirty a second; and the width of the communication channel assigned to the transmission is about 4.0 to 4.5 megacycles a second (approximately 450 times the space required by a broadcasting station). Working at its best, a system of this kind is capable of reproducing a picture having a quality roughly equivalent to that of a good sixteen-millimeter home movie, with total visible detail a quarter that to be found in the professional thirty-five-millimeter motion picture. (*Continued on page 130*)

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WHAT'S HAPPENED TO TELEVISION?

(*Continued from page 129*)

Whether a television picture like this is capable of supporting an entertainment service is of course a very important question. The prevailing opinion seems to be that the system is perfectly capable of supporting a service carefully planned with the limitations in mind, but that eventually a more detailed image will be demanded. The word "eventually" is important because at present television technique has not progressed to the point where an image of substantially greater detail than this can be produced in a commercially practical system. The question is whether we should go ahead with the present realizable system or whether we should delay commercial operation until the engineers find the way to provide the better image. Were it simply a matter of waiting for a short period of time until techniques now in the laboratory should be reduced to commercial practice, there could hardly be any argument about the more desirable procedure. But the situation is not so simple. The technical answer is not in sight. Moreover, other matters have to be considered.

One of the crucial points is the number of stations which can be accommodated in the spectrum, a question which in turn bears on the degree to which the assignees of television station licenses shall monopolize the ether. The Federal Communications Commission, on the recommendation of the Radio Manufacturers Association several years ago, established the total amount of ether space to be allocated to each station at six megacycles a second, sufficient for the 4.5-megacycle channel previously mentioned and for other technically necessary space, including that for the accompanying sound broadcasts. This amount allows about seven useful television channels at present. Now it is a fact that if the number of details in the picture is to be doubled, for example, the amount of ether space per station must be doubled, and the number of available station assignments thereby halved. Here, then, is a decision of quality versus quantity. Shall there be, eventually, a better television image but a reduced choice of programs? This is the sort of judicial nicety for which a governmental agency's judgment is required, because it is not a matter of engineering; it is a matter of the public interest, convenience, and necessity. The F.C.C. in the present deliberations has let it be known that the six-megacycle allocation is its choice and that this figure may be used as the basis for the deliberations of the National Television System Committee.

At the same time, the commission points to the possibility of twelve-megacycle assignments in a region of the spectrum not yet available, implying that future developments may be taken care of on these as yet unuseful channels. Here the ugly specter of obsolescence reappears, since receivers designed for the six-megacycle channels cannot do justice to the twelve-megacycle broadcasts, nor is it likely that the former could be used at all, especially since the number of lines per picture would be increased, roughly, from 450 to 700. While receivers could be built to cover both values, the expense of so doing would hardly be justified. The implication is that if the original degree of usefulness of the six-

megacycle receivers is to be retained indefinitely, the broadcasters must operate two sets of stations, one for the old receivers, another for the new. This possibility, however, is far in the future, far enough for the Federal Communications Commission to be content to have standards drawn up solely on the basis of the six-megacycle channel.

Once this major aspect of ether space is decided, the subsidiary questions can be attacked. First of all comes the question of the relative degree of detail in the vertical and horizontal dimensions. Offhand it appears that these two degrees of detail should be the same, but tests have shown that a considerable amount of disparity may exist before the eye can detect it. The number of lines in a picture is hence not the bugbear it was once considered to be. For ordinary subject matter almost any value from 400 to 600 lines a picture can be chosen without affecting the picture visibly, as long as the communication channel width is fixed.

Next comes the question of how many separate pictures, or frames, should be sent a second. If the number of pictures is reduced, the detail in them may be proportionately increased, with a given communication channel. Hence the suggestion has been made that only fifteen frames be sent each second, rather than the previously established thirty frames, thus allowing a doubling of the total pictorial detail without a widening of the communication channel. The slower rate of reproduction tends to introduce flicker in the result and to limit the speed with which objects in the picture can move without appearing to proceed in jumps. This matter can be decided only by performance tests, many of which are now being carried out. The committee's judgment will presumably be revealed at the scheduled meeting with the commission.

A third question which arose soon after the National Television System Committee got under way was that of color television. Experiments with color television are not new; most of them produced such poor results or cost so much to operate that none was considered until Peter C. Goldmark of the Columbia Broadcasting System demonstrated colored transmissions late last summer.

These color reproductions were excellent, and the system could be accommodated on the six-megacycle channel. The pictorial detail was lessened somewhat to allow introduction of the color aspect, and the receiver demonstrated had a rotating disk containing colored filter segments, which would presumably increase the cost of the receiver. But the system seemed reasonably satisfactory in nearly all respects except one. At the time of the demonstration, no satisfactory method of thus televising subjects directly in the flesh had been developed. The demonstration was reproduced from colored slides and motion-picture film. A partially satisfactory method of televising in color directly has since been reported but not demonstrated. Whether or not provision should be made for the introduction of color transmissions as soon as the method is perfected, is another question put up to the N.T.S.C. Its considered opinion on this matter will also, presumably, be reported to the Federal Communications Commission late this month. (*Continued on page 132*)

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WHAT'S HAPPENED TO TELEVISION?

(*Continued from page 131*)

The organization of the National Television System Committee follows the proved plan of delegating the fact finding and the preliminary decisions to small groups. In the N.T.S.C. are nine such subcommittees, or panels, each having a specific function. Panel No. 1, headed by Dr. Goldmark of C.B.S., is charged with the analysis of American and foreign television systems as a whole, those which have seen service as well as those proposed. This panel is composed of eleven men who have a broad outlook on the field. Panel No. 2, under Alfred N. Goldsmith, consulting engineer, is investigating the subjective aspects of television reproduction. Dr. Goldsmith's group of ten specialists in optics, biophysics, photography, psychology, and ophthalmology includes Professor Arthur C. Hardy, '18, of M.I.T. Under J. E. Brown of the Zenith Radio Corporation, panel No. 3 contains seventeen men charged with investigation of the specific standards relating to the spectrum occupied by a television station, including the location of the channels for sound and for picture and the space to be occupied by each. Panel No. 4, headed by Elmer W. Engstrom of the RCA Manufacturing Company, is composed of twelve men who concern themselves with the power of television transmitters, sight as well as sound, and their signal-producing capabilities.

The fifth panel, thirteen men under B. Ray Cummings of the Farnsworth Television and Radio Corporation, is considering the essential characteristics of the transmitted wave, such as the manner in which the tones shall be sent (as positive or negative) and how the "black" reference level against which the half tones are depicted shall be transmitted. Panel No. 6, under I. J. Kaar of the General Electric Company, deals with the standards which must be co-ordinated in the design of transmitter and receiver to secure maximum use of the channel. The seventeen men in this panel must see to it that simple ways of matching the receiver and transmitter are offered for standardization. Panel No. 7, of which Daniel E. Harnett of the Hazeltine Service Corporation is in charge, deals with picture resolution, including the number of lines per picture and the number of pictures per second, discussed above. This is the largest group, twenty-two men in all, a fact which attests the basic importance of its recommendations. The eighth panel is concerned with another vital bone of contention: the method to be employed to keep the scanning process in step at transmitter and receiver, the question of synchronization. Nineteen panel members under T. T. Goldsmith, Jr., of the Allen B. DuMont Television Company are attacking this problem. The ninth and final panel deals with the polarization of the transmitted wave, another subject of no little argument. This subject concerns the direction (horizontal or vertical) of the electric vector in the transmitted wave, an esoteric matter on its face but destined to have an effect on the architectural aspect of homes fitted with television receiving aerials.

The main committee, to which the panels report, is composed of eighteen members and twelve alternates under the chairmanship of Walter R. G. Baker of the General Electric Company, director of engineering for

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the Radio Manufacturers Association. To Dr. Baker was assigned the task of organizing and completing the basic personnel of the committee. The National Television System Committee, it should be remarked, is not a part of the R.M.A. but an independent body sponsored by the association with the active support of the Federal Communications Commission.

In the space of less than four months, these groups of men met thirty-four times (one panel met eight times in that period), attended twelve test demonstrations at various laboratories, prepared seventy-six documents on assigned technical aspects of their panels' work, collected bibliographies and other miscellaneous information. This record is little short of monumental, judged by any standard. It is the work of engineers who have their hearts as well as their minds in the work. Their good will is manifest. It deserves the good will of the public and the government to which their recommendations will soon be made.

THE TREND OF AFFAIRS

(*Continued from page 106*)

killer boats bringing their catch to the mother ship for rendering and storage of products. Like the New England merchants who financed the wooden fleets, stockowners in the present ventures expect and often receive unusually high returns. Today, however, whaling ships are so packed with mechanical and chemical equipment that they have gradually grown to a maximum size of over 20,000 gross tons. Norwegians rather than Yankees man these ships, and Norwegian names like Foyn, Christensen, and Gjeldstad are associated with the technical innovations of the industry. The whale oil that made New Bedford a boom town was used almost exclusively for illumination. Today's much cleaner and purer product goes mainly into margarine, lard substitutes, and soaps. Nineteenth Century whalers, who were limited to the few species of whales which floated when dead, lost a good many of the whales they struck and salvaged only the oil in the blubber, and the whalebone, if any. Today's whalemen rival the packers in their efficiency, practically none of the whale going over the side. The Japanese actually pack a good part of the whale meat they obtain, and the Germans might have done likewise had the British blockade not interfered.

Whale oil is by no means the least of the products which the British blockade has denied Germany. World production has been running to about 500,000 tons a year, a trifle by comparison with the world production of 21,000,000 to 22,000,000 tons of animal and vegetable fats, but disproportionally important to Great Britain and Germany, who were in the habit of using most of it. Between 30 and 40 per cent of Germany's margarine and lard compound came from hydrogenated whale oil, while Great Britain classed the oil in importance with wheat and sugar when she began to store foods in 1938.

Gas Turbines on Wheels?

A HEN, it has been said, is merely an intermediate stage between one egg and another egg. Somewhat comparably, a reciprocating engine is an intermediate stage between a steady fuel supply and a steady driving effort. Its back-and-forth action and multiplicity of moving parts are by-products in the quest for a simple and steady motion. In contrast is the obvious appeal in the apparently simple action of a turbine, which involves only a bucket-wheel rotor driven steadily by steam, water, or hot gases.

Although the seeming simplicity of the turbine is somewhat deceptive, the operation of turbines has been mastered to the extent that all hydropower plants and most large steam-power plants use turbines in the interests of maximum economy. In the generation of power by the internal combustion of fuel, however, the gas turbine has lagged far behind the reciprocating engine. Similar in many respects to the steam turbine, a typical gas turbine burns fuel oil in a combustion chamber, allows the resultant gases to expand in a nozzle, and then utilizes the kinetic energy of the (*Concluded on page 134*)

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THE TREND OF AFFAIRS

(*Concluded from page 133*)

gases as they strike the blades of the turbine wheel. Fundamental designs for workable gas turbines have long been known, but only in the last few years have economically practical installations been developed. Almost the only common applications today are for the propelling of torpedoes and for the supercharging of airplane engines. An oil-fired gas turbine locomotive, however, has been announced as in the offing, to compete with the most modern of steam, Diesel, and electric engines; its sponsors predict that for certain purposes it may prove the best of all.

Until recently, gas turbine applications were confined principally to places which had cheap supplies of medium-pressure gaseous fuel or of high-velocity gases. Otherwise the turbine installation had the disappointing net effect of consuming within itself nearly all of the power generated. Useful though expensive power may be obtained from poorly designed engines of most other types, but an oil-fired gas turbine installation will produce no useful output at all unless its individual parts are of high efficiency.

The common oil-fired gas turbine plant has two principal units: the turbine itself and a compressor to supply air for combustion and for cooling. Usually, both units are mounted on the same shaft, and the compressor uses a large portion of the power developed by the turbine. Starting is accomplished with the aid of a small auxiliary engine. The useful power output is the difference between the power developed by the turbine and that required to drive the compressor — a difference which can easily be zero if both turbine and compressor are not of the best possible design. Recent advances in the efficiency of turbines and compressors, however, indicate that a gas turbine power plant burning fuel oil can compete with other modern sources of power.

As power plant for a locomotive, the gas turbine may drive the wheels by means of either fluid transmission or a conventional electric system of a generator and motors. With either drive, the fuel-to-wheel efficiency is expected to be 14 per cent or higher, giving much better fuel economy than do modern steam reciprocating engine locomotives of only 8 to 12 per cent efficiency. The latest turboelectric locomotive has approximately the same efficiency as that expected from the gas turbine but is considerably more complex in that it requires a boiler and condenser. Diesel locomotives are of higher efficiency but burn a more expensive oil, their apparent advantage thus being reduced by fuel costs. For a given physical size of locomotive, it is believed that a gas turbine could supply twice the output obtainable from Diesel power.

A modern Diesel-electric locomotive has about half the fuel expense of a low-pressure steam reciprocating locomotive and costs about four times as much to build. The gas turbine locomotive is expected to permit much greater fuel economy than does the ordinary iron horse and to be of less initial cost than is the Diesel.

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There are a lot more of today's home conveniences that we wouldn't trade for their counterparts of the "good old days." The electric washer, for instance, for the scrubbing board; the electric light for the messy coal-oil lamp; the furnace for the parlor base-burner.

Most of us are incomparably richer than the people of a generation ago—not so much in money, perhaps, but in the things our money will buy. And in most cases these are the products of American industry—manufactured articles that have been developed by industry, improved, made less and less expensive so that more millions of people can afford to own them.

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GENERAL ELECTRIC

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PRECISION APPARATUS

SEVERAL years ago General Radio assigned an engineer to investigate the design of small fixed condensers having sufficient stability and low losses for use in precision circuits, such as beat-frequency oscillators, bridges and standard-signal generators.

The available condensers had several serious shortcomings including very poor stability with time, inexact accuracy of adjustment, high and variable power factor.

After a number of months of research, the Type 505 and Type 509 Condensers were developed. While designed primarily for use in G-R instruments, hundreds of these condensers have been sold separately for precision circuits and apparatus.

In the Types 505 and 509 Condensers selected India mica is used, each piece being carefully inspected for scratches and other mechanical defects which cause high dielectric losses. Mica, despite its excellent dielectric properties, is fairly high in its moisture absorption characteristics, a property which adversely affects its power factor. In these condensers the mica and its associated tin foil are kept at a temperature of 300 degrees F for a considerable time before the condensers are assembled, during assembly, and thereafter until sealed.

To keep the condensers dry after assembly, they are placed in a bakelite case with a mixture of silica gel and ground cork and are then sealed with an Ozite compound. The amount of desiccant sealed in is such that there can be 2,000 complete changes of air due to leakage before the desiccant will be used up.

Changes in pressure can cause appreciable changes in capacitance. In these condensers the stack is heavily loaded with a stiff spring under considerable tension to a point where the change in capacitance with pressure is very small. During assembly, each unit is carefully aged through a number of heat cycles to increase stability.

The resulting characteristics are such that these condensers make admirable secondary standards of capacitance and are of such physical form that they are readily adapted to use in precision measuring instruments. All Type 505 units are adjusted within 1% or 10 μμf whichever is larger, and Type 509 units within ¼%; the temperature coefficient of capacitance is less than +0.01% per degree C between 10 degrees and 50 degrees; the power factor of almost all of the units at 1,000 cycles and 25 degrees C is less than 0.05%; the leakage resistance in most of the units is greater than 100,000 megohms. These condensers are available in standard capacitances from 100 μμf to 1 μf at prices between $3.50 and $48.00.

GENERAL RADIO COMPANY
Cambridge, Massachusetts
BRANCHES IN NEW YORK AND LOS ANGELES

Since 1915 Manufacturers of Precision Electrical Laboratory Apparatus

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